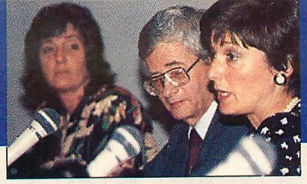
LIVE FROM THE SYSTEMS FORUM ▶



COMPAQ'S 386S, IBM'S MODEL 70

OCTOBER 1988

VOL. 6 NO. 10 $3.95

PC TECH JOURNAL®

FOR SYSTEMS DEVELOPERS AND INTEGRATORS

DEVELOPING FOR CD-ROM

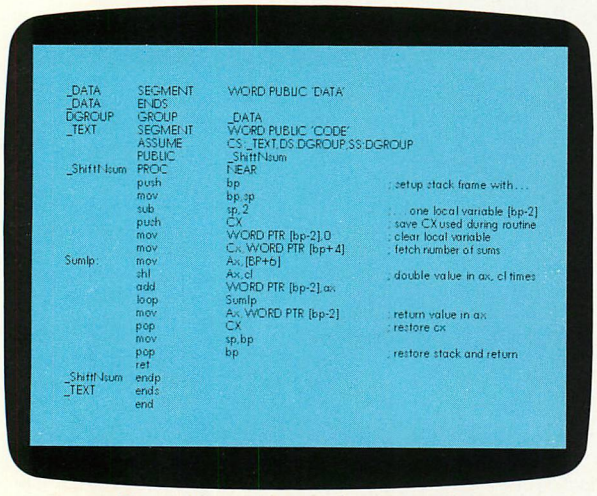
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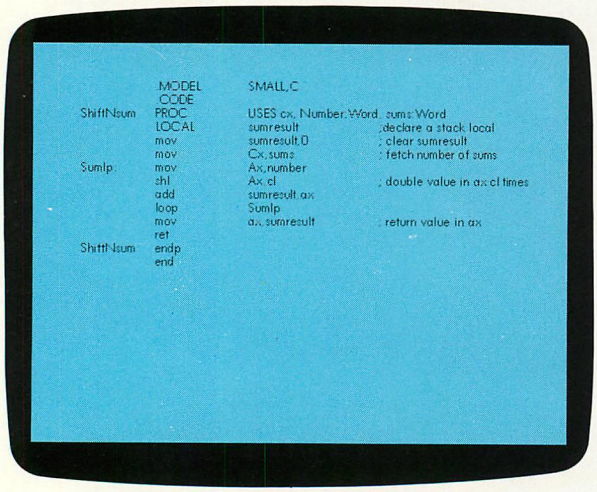
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MS OS/2 and spare time.



```
_DATA     SEGMENT   WORD PUBLIC 'DATA'
_DATA     ENDS
DGROUP    GROUP     _DATA
_TEXT     SEGMENT   WORD PUBLIC 'CODE'
          ASSUME    CS:_TEXT,DS:DGROUP,SS:DGROUP
          PUBLIC    _ShiftNsum
_ShiftNsum PROC     NEAR
          push      bp                      ;setup stack frame with...
          mov       bp,sp
          sub       sp,2                    ;  one local variable [bp-2]
          push      CX                      ;save CX used during routine
          mov       WORD PTR [bp-2],0       ;clear local variable
          mov       Cx, WORD PTR [bp+4]     ;fetch number of sums
SumIp:    mov       Ax,[BP+6]
          shl       Ax,cl                   ;double value in ax, cl times
          add       WORD PTR [bp-2],ax
          loop      SumIp
          mov       Ax, WORD PTR [bp-2]     ;return value in ax
          pop       CX                      ;restore cx
          mov       sp,bp
          pop       bp                      ;restore stack and return
          ret
_ShiftNsum endp
_TEXT     ends
          end
```

The old way: slow, cumbersome coding.



```
          .MODEL    SMALL,C
          .CODE
ShiftNsum PROC      USES cx, Number:Word, sums:Word
          LOCAL     sumresult               ;declare a stack local
          mov       sumresult,0             ; clear sumresult
          mov       Cx,sums                 ; fetch number of sums
SumIp:    mov       Ax,number
          shl       Ax,cl                   ; double value in ax cl times
          add       sumresult,ax
          loop      SumIp
          mov       ax,sumresult            ; return value in ax
          ret
ShiftNsum endp
          end
```

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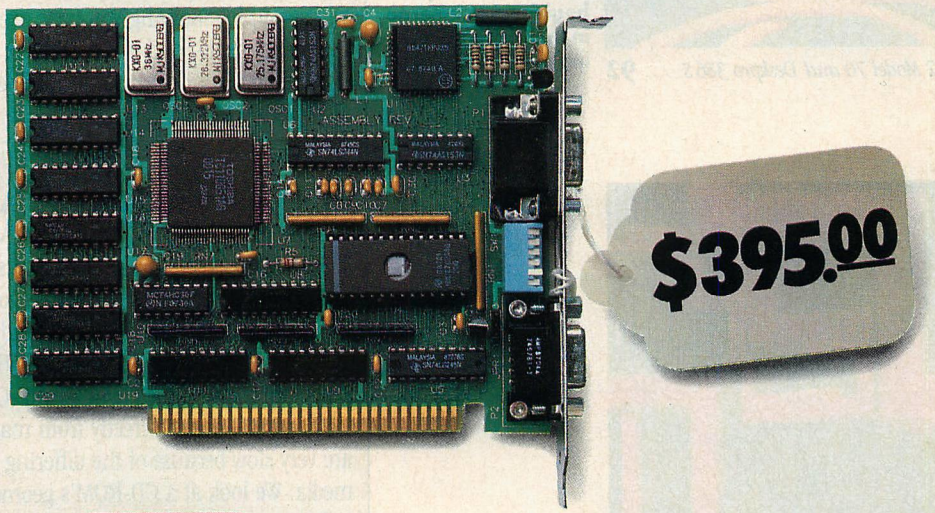
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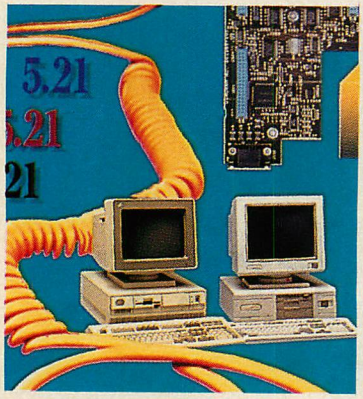
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OCTOBER 1988

PC TECH JOURNAL

FOR SYSTEMS DEVELOPERS AND INTEGRATORS



PS/2 Model 70 and Deskpro 386S **92**

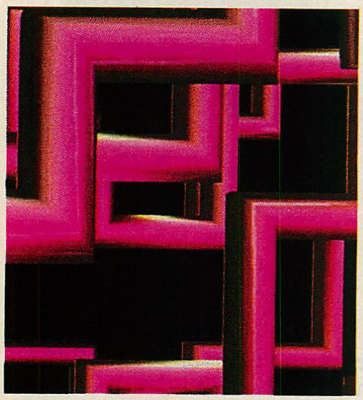
COVER SUITE: DEVELOPING FOR CD-ROM

Compact disks, with their immense storage capacity, open up new ways to use the PC, but they also mean new procedures for the developer. The development issues are just beginning to emerge in this rapidly growing industry.

CD-ROM PUBLISHING STRATEGIES

LINDA W. HELGERSON and FRED P. MEYER

How do you know if CD-ROM is the appropriate medium for your particular project? How do you structure your data to suit a CD-ROM? What specialized hardware and software are necessary to support CD-ROM development on a PC? We examine these development issues and take you through the steps of CD-ROM production—from analyzing your requirements to producing a glass master disk. The process will sound like nothing you have experienced with traditional magnetic media, and it is a difficult undertaking. But for the right application, CD-ROM technology holds great promise. **52**



Omnis Quartz Data Manager **112**

IN SEARCH OF CD-ROM DATA

LINDA W. HELGERSON and HARVEY G. MARTENS

The enormous volumes of data that seem to stretch out forever on a CD-ROM are not all that easy to find. They require special indexing and retrieval methods. Traditional methods, which were developed for files of less than 1MB on 100MB magnetic disks, are overwhelmed by a 600MB CD-ROM. Retrieval times for databases ported directly from magnetic media to CD-ROM are very slow because of the differing geometries of the two media. We look at a CD-ROM's geometry and describe various indexing methods, explaining which are most appropriate for which databases. Finally, we present practical applications and the indexing and retrieval methods they use. **66**

SPECIAL REPORT



Systems Forum '88 **78**

DESKTOP DEBATES 2.0

SUSAN HOLLY

Like a new release of software, discussions during *PC Tech Journal*'s second annual Systems Forum retained many features from last year's Forum, added some sophistication, provided a few updates, but still left many problems unsolved. Most of the same hot topics dominated again this year: OS/2, graphics user interfaces, faster processors, different buses, Structured Query Language, distributed data management, and networks. Everyone agreed the desktop is growing more complicated all the time and requires increased expertise in more areas. No one had any easy answers, but many of the suggestions were intriguing. **78**

COMPUTER SYSTEMS

Product reviews:
Deskpro 386S
PS/2 Model 70-E61

386 POWER TO THE PEOPLE

DAVID CLAIBORNE

Bigger is better? Not necessarily. Compaq and IBM have reduced both the size and cost of their recent 386 entries. The Deskpro 386S, which uses Intel's new 386SX processor, and the PS/2 Model 70-E61 are more compact than other 386-based computers and closer in cost to 286 machines. Tested head to head, the 386S and Model 70-E61 prove almost identical in function, each with its own set of strong points. These entry-level 386 machines may be just the ticket for those torn between the power of a 386 and the cost of a 286. 92

DATA MANAGEMENT

Product review:
Omnis Quartz

OMNIS QUARTZ OPENS WINDOWS

DAVE BROWNING

Blyth Software has taken a gallant first step toward integrating a graphics interface with data management applications. Its Omnis Quartz was developed for Microsoft Windows and goes a long way toward easing the pain for end users. As a development tool, however, it is somewhat limited. 112

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Succeeding at CD-ROM/JULIE ANDERSON

CD-ROM offers great potential, but challenges the developer. Microsoft's Bookshelf and Programmer's Library exemplify the new applications already possible with this medium. 9

NEW DIRECTIONS

Future of Software Engineering/WILL FASTIE

The state of the software development process is abysmal. It lacks order, systemization, and standards. The path toward improvement points toward automating the developer. 21

OUTFITTING THE END USER

The Ziggurat Zone/PETER C. COFFEE

The taller the tower, the closer it brings you to the source of all truth and power—or so goes the legend of the Tower of Babel. Has this myth overtaken the PC industry? 151

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131 **PRODUCT WATCH**
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(2) Windows/386 on token-ring networks.
(3) The XT-AT Handbook.

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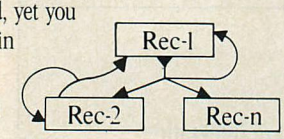
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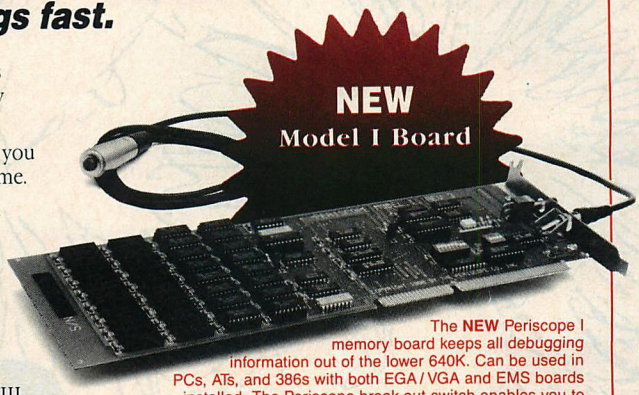
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Periscope's *New* Version 4

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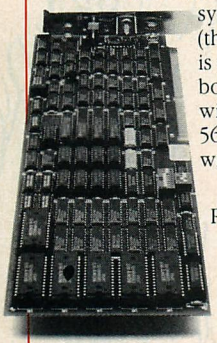
Periscope's hardware adds the power to solve the really tough debugging problems.

The break-out switch lets you break into the system any time. You can track down a bug instantly, or just check what's going on, without having to reboot or power down and back up. That's really useful when your system hangs! The switch is included with Periscope I, Periscope II, and Periscope III.



The **NEW** Periscope I memory board keeps all debugging information out of the lower 640K. Can be used in PCs, ATs, and 386s with both EGA / VGA and EMS boards installed. The Periscope break-out switch enables you to recover from a hung system. Included with Models I, II, and III.

Periscope I has a **NEW** board with 512K of write-protected RAM, user-expandable to 1MB, for the Periscope software, symbol tables, and all related debugging information. Normal DOS memory (the lower 640K) is thus totally freed up for your application, and Periscope is protected from being overwritten by a run-away program. The new board's footprint is only 32K, so you can use it in PC, AT, and 386 systems with EGA/VGA and EMS boards installed (not possible with the previous 56K board). It can also be used with Periscope III to provide additional write-protected memory.



Periscope III has a board with 64K of write-protected RAM to store the Periscope software and as much additional information as will fit. AND...

The Periscope III board adds another powerful dimension to your debugging. Its hardware breakpoints and real-time trace buffer let you track down bugs that a software-oriented debugger would take too long to find, or can't find at all!

The Periscope III hardware-breakpoint board captures information in real-time, so you'll find bugs that can't be found with a software-based debugger.

Periscope's software is solid, comprehensive, and flexible.

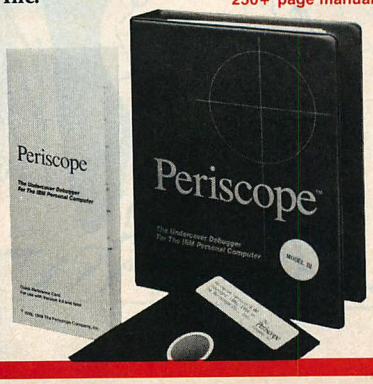
It helps you debug just about any kind of program you can write... thoroughly and efficiently.

Periscope's the answer for debugging device-drivers, memory-resident, non-DOS, and interrupt-driven programs. Periscope works with any language, and provides source and/or symbol support for programs written in high-level languages and assembler.

David Nanian, President of Underware, Inc. (of BRIEF fame) says this about the new Periscope Version 4:

"Periscope has always been an unbelievable assembler-level debugger. Version 4 has turned it into a terrific source-level debugger as well. Aside from major enhancements like the source-level improvements, all the little changes make a really big difference, too. For instance, symbol lookups and disassemblies are noticeably faster, and highlighting the registers that have changed really makes life easier. Once again, Periscope has raised the industry standard for debuggers!"

Periscope software & 250+ page manual



What's New in Periscope Version 4:

- View local symbols from Microsoft C (Version 5)
- Debug Microsoft windows applications
- Set breakpoints in PLINK overlays
- Improved source-level support
- Monitor variables in a Watch window
- 80386 debug register support
- Debug using a dumb terminal
- PS/2 watchdog timer support
- Use mixed-case symbols
- Set breakpoints on values of Flags
- Much more!

- **Periscope I** includes a **NEW** full-length board with 512K of write-protected RAM; (user-expandable to 1MB); break-out switch; software and manual for $695.
- **Periscope II** includes break-out switch; software and manual for $175.
- **Periscope II-X** includes software and manual (no hardware) for $145.
- **Periscope III** includes a full-length board with 64K of write-protected RAM, hardware breakpoints and real-time trace buffer; break-out switch; software and manual. Periscope III for machines running up to 10 MHz with one wait-state is $1395.

Due to the volatility of RAM costs, prices on board models are subject to change without notice.

REQUIREMENTS: IBM PC, XT, AT, PS/2, 80386 or close compatible (Periscope III requires hardware as well as software compatibility, thus will not work on PS/2 or 80386 systems); DOS 2.0 or later; 64K available memory (128K at installation time); one disk drive; an 80-column monitor.

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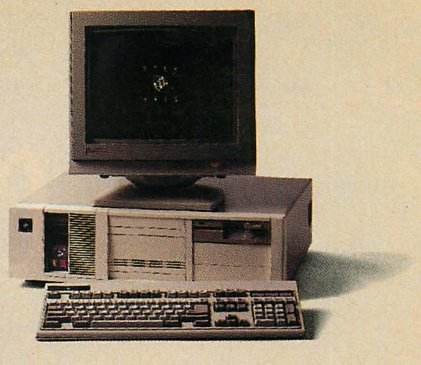
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JULIE ANDERSON



J Anderson

SYSTEMS PERSPECTIVE

Succeeding at CD-ROM

CD-ROM is off to a promising start; two products from Microsoft provide a taste of things to come.

Unlike many new technologies, CD-ROM was born into a family of standards. Philips and Sony defined the disk's physical layout; 13 vendors in the High Sierra Group designed a file structure that the International Standards Organization (ISO) then numbered among its standards; and Microsoft delivered the CD-ROM extensions for accessing 600MB of data as if they were stored in a single volume on a local hard disk.

Despite all this helpful groundwork, developing a CD-ROM application holds many challenges. In fact, the developer plays the most crucial role in the success or failure of a CD-ROM application. It is the design of the application—the front-end search strategies and the back-end indexing and retrieval methods—that determines whether the application will be usable and useful. This month's cover suite looks at some of the issues of developing for CD-ROM.

Successfully designing a CD-ROM application means understanding how it differs from traditional data-processing applications. The differences lie in how the data are used and stored.

Typically, CD-ROM data are not processed, but merely retrieved. Of critical importance, therefore, is building a search interface to sift through 600MB of stored data and filter out extraneous information. The search interface should aid users in building queries that will retrieve the items they need, all the items they need, and nothing but the items they need.

Meeting this challenge means deciding how to store the information on the CD-ROM. Not only does the developer need to determine the best index method to use, but also *what* to index. This, of course, depends on the nature of the data and their intended use.

The special characteristics of CD-ROM technology require the developer to take a fresh look at storage-and-retrieval methods. Because a CD-ROM drive is read-only, many traditional data-access methods do not apply. Furthermore, the average access time for a CD-ROM is 14 times slower than most hard disks in 386 machines.

Under DOS, the developer has little control or concern about where an application's files are stored. A CD-ROM, however, offers the luxury of creating files of arbitrary sizes and placing them anywhere on the disk. Again, because the CD-ROM is read-only, files do not move, change, or become fragmented.

How the data are organized into directories and files and where the files are located on the CD-ROM can greatly influence access time and, therefore, system performance. Another aid to performance is caching indexes and search results on your hard disk in order to avoid seeks to the CD-ROM whenever possible.

IT'S BEEN DONE

Two products from Microsoft show off some of CD-ROM's potential as a development medium. One product that positively sparkles is Microsoft's Bookshelf. For $295, ten reference books are placed at the business writer's fingertips on one CD-ROM, including *The American Heritage Dictionary*, *The World Almanac and Book of Facts*, *Bartlett's Quotations*, *Forms and Letters*, and the *US ZIP Code Directory*.

When you buy Bookshelf, you are getting more than the data—buying all ten of these references at the corner bookstore would cost about the same as Bookshelf itself. Naturally, you also will need a CD-ROM drive, controller card, cables, and software—at a cost of between $700 and $1,000. Bookshelf can be accessed on a network using drivers supplied by Online Computer Systems Inc., so the total cost can be split among all users.

What you are really paying for, then, is accessibility: the ability to get to the data quickly and easily, to integrate a fitting quotation into a document, to add the correct ZIP code to the address of a letter, or to find the meaning of a word as well as its correct spelling.

The key to Bookshelf's effectiveness is its superior search interface. Designed to run either as a stand-alone program or as a memory-resident program behind your word processor, Bookshelf presents a customized search form for each reference.

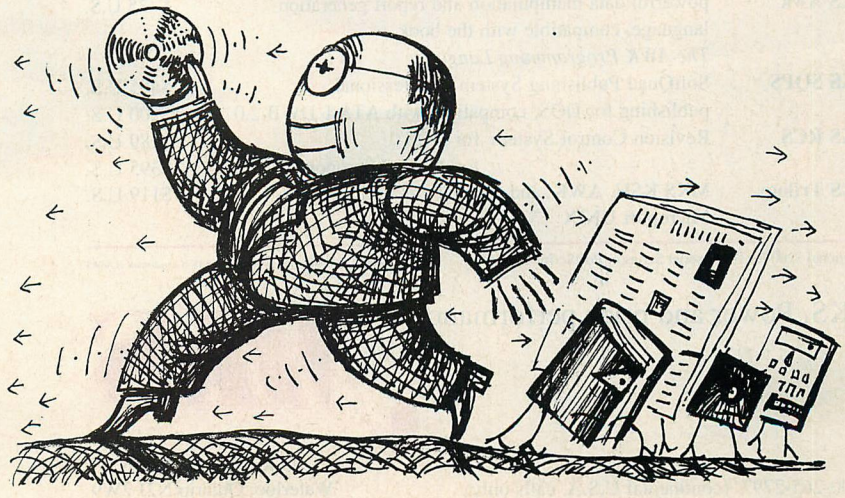


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CIRCLE NO. 174 ON READER SERVICE CARD

Finding a ZIP code is an especially impressive function. With your cursor resting after the city and state of an address, press Alt-Shift to activate Bookshelf. Choose the ZIP option, and Bookshelf presents a search form with the street address, city, and state already filled in (Bookshelf gleans what it can from your document). Next, select Lookup and then Insert. Bookshelf places the correct ZIP code into the address. This is definitely a class act.

Unfortunately, the length of the search time may test your patience—after 8 seconds has passed, 386 owners will have their fingers ready to press Ctrl-Alt-Del. Considering that it would take several *minutes* to look up the ZIP code manually, however, 8 seconds is an acceptable response time.

Microsoft's Programmer's Library, on the other hand, is very fast at retrieving information, if you know what you are looking for. For $395, the Programmer's Library offers documentation for Microsoft's languages, MS-DOS, OS/2, and hardware (including the Microsoft Mouse and CD-ROM extensions), along with several Microsoft Press books and plenty of sample code.

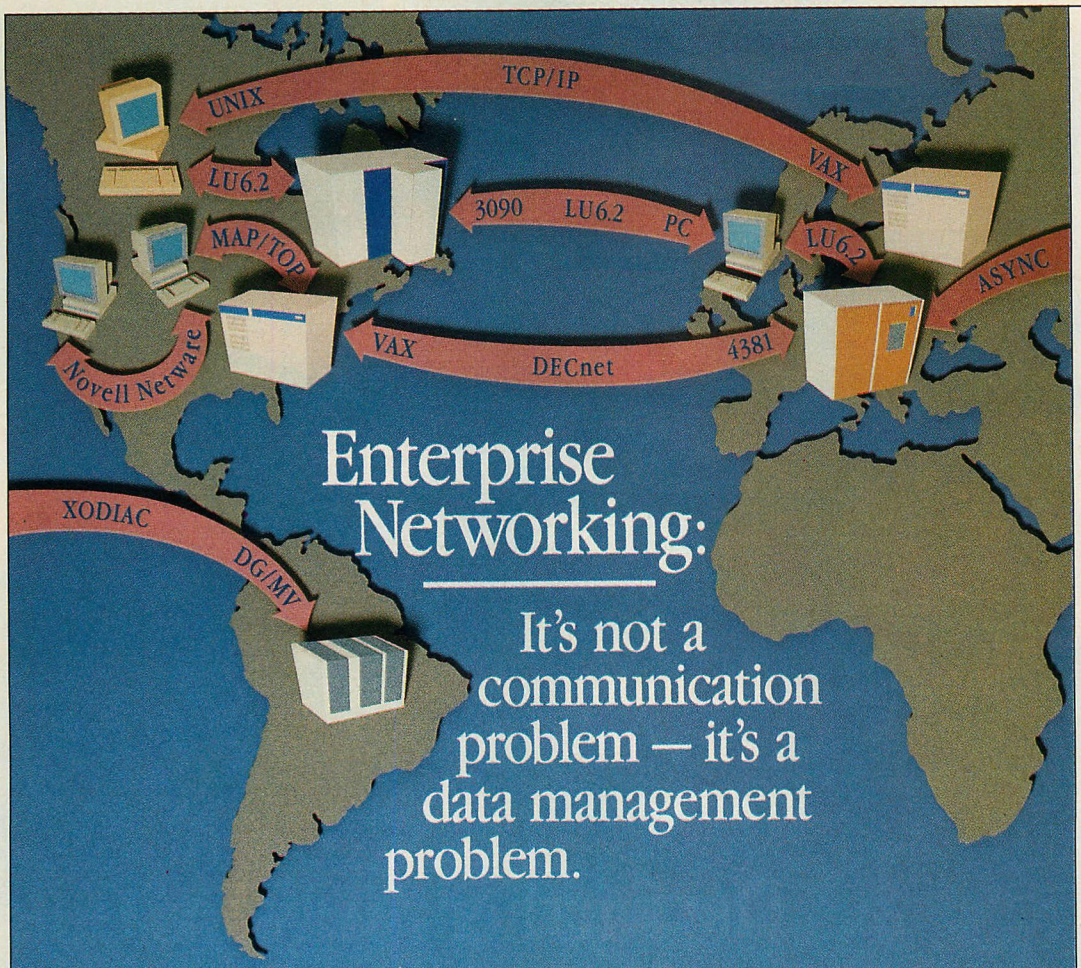
The search interface of the Programmer's Library returns chapter titles, section names, or the first lines of paragraphs containing the target word or phrase. The Programmer's Library can respond to searches quickly because the first line of each paragraph is stored in the index. An additional seek to the actual data is not necessary until you read the paragraph.

The only problem I had was figuring out the context of the search hit. You can zoom in to see the surrounding text, and you can determine the chapter and section name in which the target of the search is located. The displayed text, however, is centered around the search target, while the beginning of the paragraph may be off the screen. This gives you the uneasy feeling of having walked into the middle of a conversation.

For looking up the syntax of a command, finding the name of a function call, or copying sample code into your text editor, however, the Programmer's Library shines.

Although not perfect, both the Programmer's Library and Bookshelf are good examples of CD-ROM search interfaces that have been customized for a particular type of data and user. They give us a good idea of the vast potential and growing future of CD-ROM technology.





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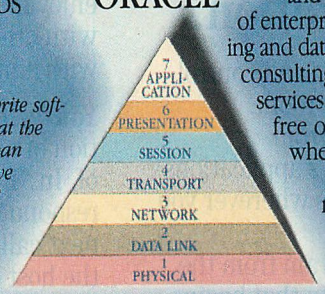
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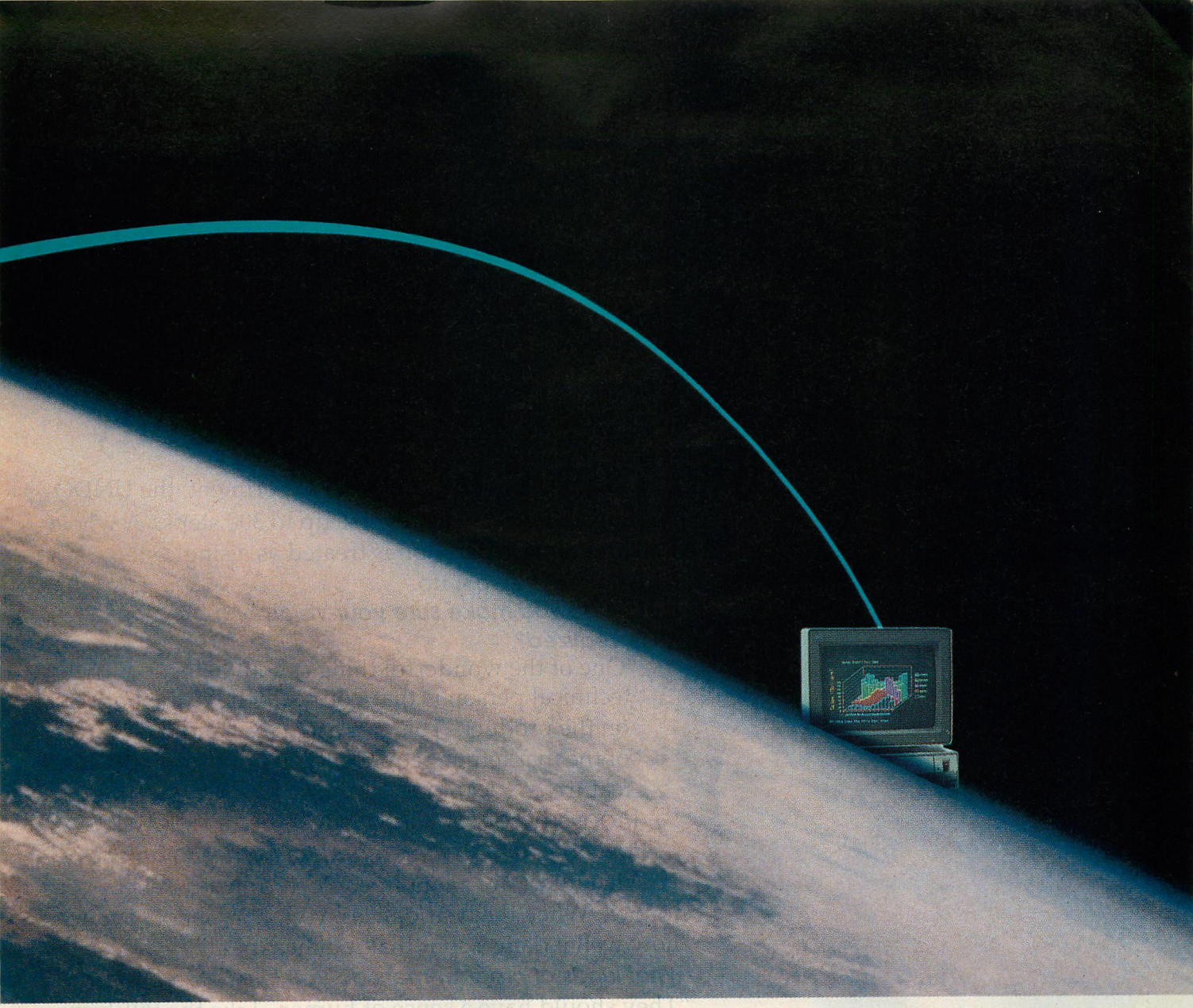
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World Class Programmers on Creativity

Dan Sevush. Project Leader on v. 2.0 Lotus 1-2-3.
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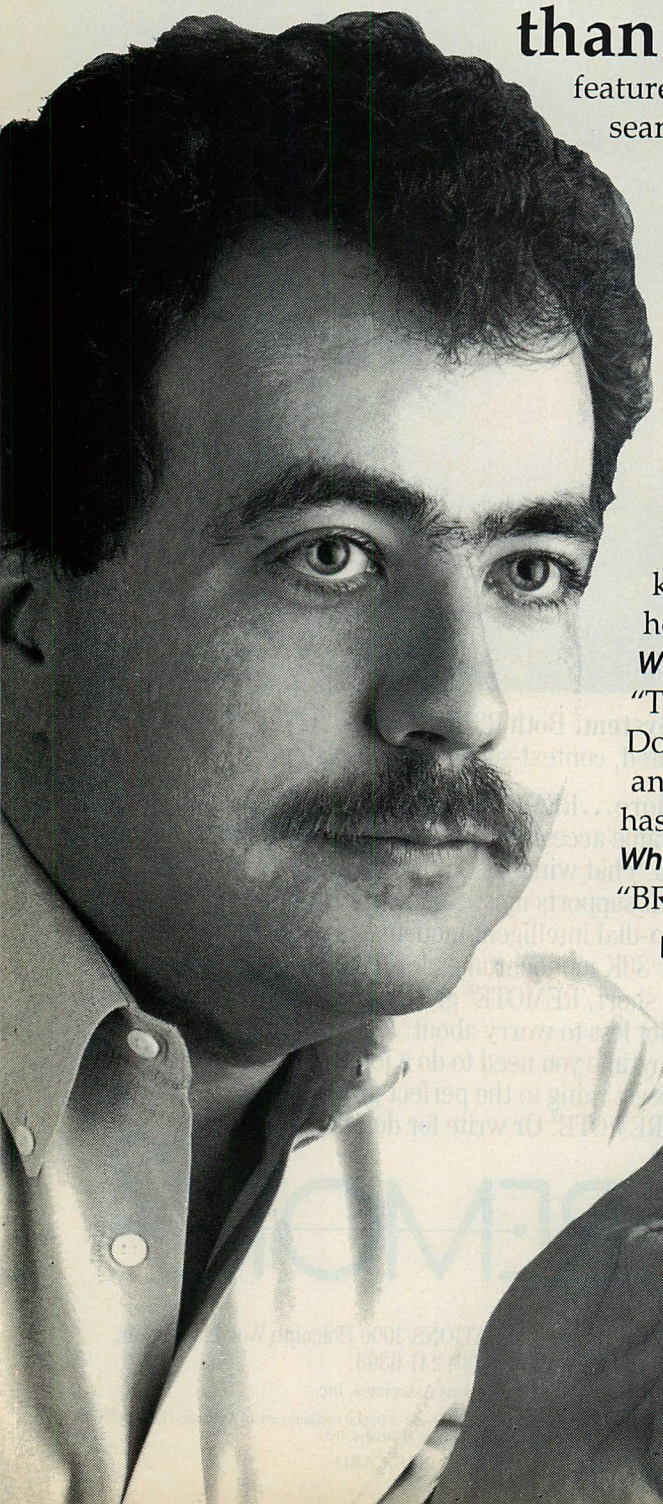
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And when you're back at your computer?

"I suffer less for my creativity than I used to.

When I experiment, the UNDO feature in my editor lets me reverse up to 300 steps. A whole search and replace iteration is treated as a single step. I would not give it up."



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How do you feel when a project comes to an end?

"When there are a lot of people, it's mostly relief. You know, 'When the bear dances, you marvel not so much how well it dances, but that it dances at all.'"

What kinds of programmers do you like to work with?

"They should have a sense of humor. Like the Pillsbury Doughboy. You push the Doughboy and he goes "Naaaa" and just bounces back. And I don't hire anyone who hasn't..."(continued — see below.)

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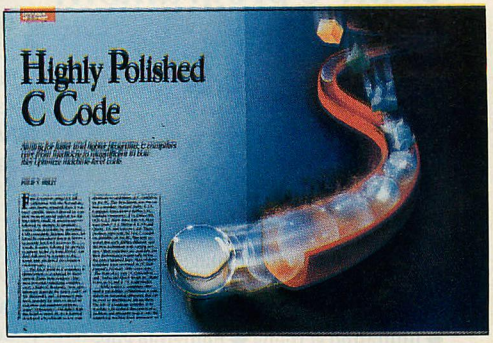
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LETTERS





OS/2 FINE POINTS

I appreciated the article "OS/2 Workshop," by Ted Mirecki (August 1988, p. 80). However, I would advise your readers to ignore his advice about the lack of utility of the include files, especially the statement: "The bottom line is to throw away the IBM include files." In fact, they probably would do well to use the IBM macros, "incredibly inefficient" though they may be.

What the author missed is that his "most efficient" call for DosChDir, as coded, will produce the desired result only under the circumstance where the variable **path** is defined in the first segment of the GROUP currently assigned, via the **assume** for segment register DS, and where the double word's value is truly zero.

Apparently, IBM's macro is intended to produce the desired result under all conditions. It seems to me that the macro-generated code cited in the article is just fine for the variable **path**. I do not have the documentation as to what the **longz** variable is supposed to be, but it apparently could contain a nonzero value and could be in a segment not currently covered by segment register DS. The generated code looks reasonable for its intended purpose. Mr. Mirecki's code will fail if it is linked as part of a GROUP and a different-named segment precedes it; the IBM code will not.

Jim Miller
Nashua, NH

My example was meant to illustrate the most efficient code for the simplest case, not the most general one. The whole purpose of programming in assembly language is to write optimum code for a given set of circumstances, not for the lowest common denominator. The example would indeed fail in the cases mentioned by Mr. Miller, but then I would not use it for those cases. Just as a compiler optimizes the code it generates to the memory model in effect, so an assembly-language programmer writes to the data organization specific to his program. Even for the worst case that the macro can handle, most programmers could hand-code a sequence that is vastly superior to the one generated by IBM's macro.

The point I tried to make was not that you should use my code in place of IBM's, but that you should write your own code tailored to each program. I stand by my evaluation of the IBM macro files—they are undesirable because they are too general.

—TM

The article on OS/2 ("OS/2 Workshop," Ted Mirecki, August 1988, p. 80) gave me a better idea of what I need to be aware of when I begin OS/2 development within the next six months. It is alarming that different vendors' versions of OS/2 will not play on other vendors' hardware. This is a far cry from the generic DOS 3.*x* from Microsoft, which will work on almost any PC that calls itself IBM-compatible.

One small item that was omitted from the article regards the availability of an OS/2 device driver writer's kit from Microsoft. I am aware of this because my first OS/2 development will be a ring-zero driver. How does this stack up with the materials available from IBM? I realize I am in the minority, because only a small handful of people will write OS/2 device drivers.

On another subject, the comments on Microsoft's *MS-DOS Encyclopedia* (Tech Notebook, Ted Mirecki, August 1988, p. 137), remind me of other omissions from this reference. I was disappointed that Microsoft did not document all interrupt 21H function calls, "reserved" or not. Useful function calls for writers of MS-DOS drivers include Get Drive Parameter Block (32H), Get DOS List of Lists (52H), and Translate BPB (53H). I think Microsoft's rational was that driver writers would license an OEM DOS kit from them, because the OEM kit tells all.

Still, if the *Encyclopedia* is represented as being complete, then it should be *really* complete. Furthermore, its discussion on terminate-and-stay-resident programs (TSRs) is a little thin, leaving out how TSRs can remove themselves from memory. The section on device drivers is little more than a rehash of a chapter from Ray Duncan's earlier book, *Advanced MS-DOS*. I would not and did not pay the list price of $134.95 for the *Encyclopedia*, but I found it worth the $50.00 or so paid to the computer book club I belong to. After all, IBM's *Technical Reference* on DOS 3.3 is about $80, and it contains only a fraction of the material found in the *MS-DOS Encyclopedia*.

Finally, I would like to comment on LANPERF, *PC Tech Journal*'s performance utility for LANs ("Network Complexity," Steven S. King, June 1988, p. 44). LANPERF is probably the most thorough disk-testing (not just LAN-testing) software—with source code—in the public domain today. Like the Novell NetWare performance test after which it seems to be modeled, it is a great lesson to software programmers on how to choose the best control interval (my COBOL is showing) to read or write. Pick small record sizes and LANPERF's throughput is low; pick large ones and it runs faster. Never satisfied, however, I might suggest random file reads and writes and open-close tests as additions.

Ben Myers
Spirit of Performance Inc.
Harvard, MA

Regarding the Microsoft OS/2 Device Driver Development Kit, we are well aware of it—it was mentioned in several previous articles on OS/2. However, obtaining the kit requires signing a licensing agreement that includes a

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broad nondisclosure clause. PC Tech Journal *cannot agree to this condition because our purpose is to disclose the results of our evaluations. We plan to publish a review if and when Microsoft relaxes its nondisclosure requirement.*

—TM

SPEED TRAP AHEAD

While I was impressed with the thorough coverage of "Highly Polished C Code" (Philip N. Hisley, June 1988, p. 76), I must disagree with the following statement made early in the article: "In the PC environment, *speed* optimizations have a higher priority because the PC generally is used by a single person, and large amounts of memory are affordable."

A statement such as this summarizes the state of affairs in the PC software industry. Why bother writing compact code when we can make the user upgrade to larger RAM? Why bother with an assembler when we have optimizing compilers? Who cares if the program is so large that it will not even fit into 640KB?

Well, I have news for everybody who thinks that speed is the overriding factor in PC software. First, we have a RAM shortage. Second, multitasking is here, which means that memory is not as affordable anymore (wholesale prices have doubled lately). Even if you have tons of memory, if one program hogs it all, the whole system will be on its knees, no matter how fast that program is. I cannot easily imagine a fast 640KB program.

It is very sad that this situation exists. I have worked with a true multiuser, multitasking operating system, MPE V on HP 3000, that ran just fine in 512KB. Compare this with the minimum memory requirement for OS/2. It certainly makes me wonder what happened to good old tight code. Remember that neither OS/2 nor any other multitasking environment will fly on a PC running a bunch of big, fat programs, no matter how sophisticated its virtual storage-management scheme is. Paging code and data in and out of memory will kill a system like that, given present I/O speeds.

I certainly hope that the demands of multitasking programming and the RAM shortage will bring this industry back to reality—that lean, tight programs will be in again, and speed optimization will not be the only concern of software developers.

Alexander Vainshtein
Calabasas, CA

CALCULATING THE POPULATION

I have a question about the article, "AST's Smart Machine" (David Claiborne, August 1988, p. 92). Photo 4 shows a board populated with eight single in-line memory modules (SIMMs), yet you say the system was tested with only 1MB of RAM (four 256MB SIMMs), and in figure 1, you show 13MB, 32-bit memory. The board in photo 4 could take as many as 16 SIMM assemblies; assuming twelve 1MB SIMMs and four 256MB SIMMs, a total of 13MB can be calculated. However, from photo 4, the SIMM assembly is populated with nine "chips," and this looks like nine bits to me. How do 32 bits come from these nine chips? Are they 256K-by-4-bit chips? Because I do not understand the population of bits in a SIMM chip, it would be helpful for you to explain if the memory referred to in the review is 8-, 16-, or 32-bit.

In an AT-class machine, which has the 16-bit bus, memory is still referred to in the 8-bit scheme of things. It looks like the manufacturers are not telling the truth about the capability of the memory. Is 13MB 8-bit memory the same power as 13MB 32-bit memory? I believe not.

Steven S. Anderson
Kimberton, PA

As noted in the article, the Premium/386 system memory board is socketed for four banks of four SIMMs. Each of the SIMMs contains nine 256K-by-1, or 1M-by-1-bit chips, for a capacity of 256KB or 1MB, respectively (eight data bits and one parity bit). Each bank is accessed as 256KB or 1MB 32-bit double words. The first four SIMMs must be 256KB modules, yielding a maximum capacity for the board of 13MB of memory, all of which is accessed 32 bits at a time. The board shown is from the Model 390 review unit, which comes standard with 2MB (eight 256KB SIMMs) of memory.

—JS

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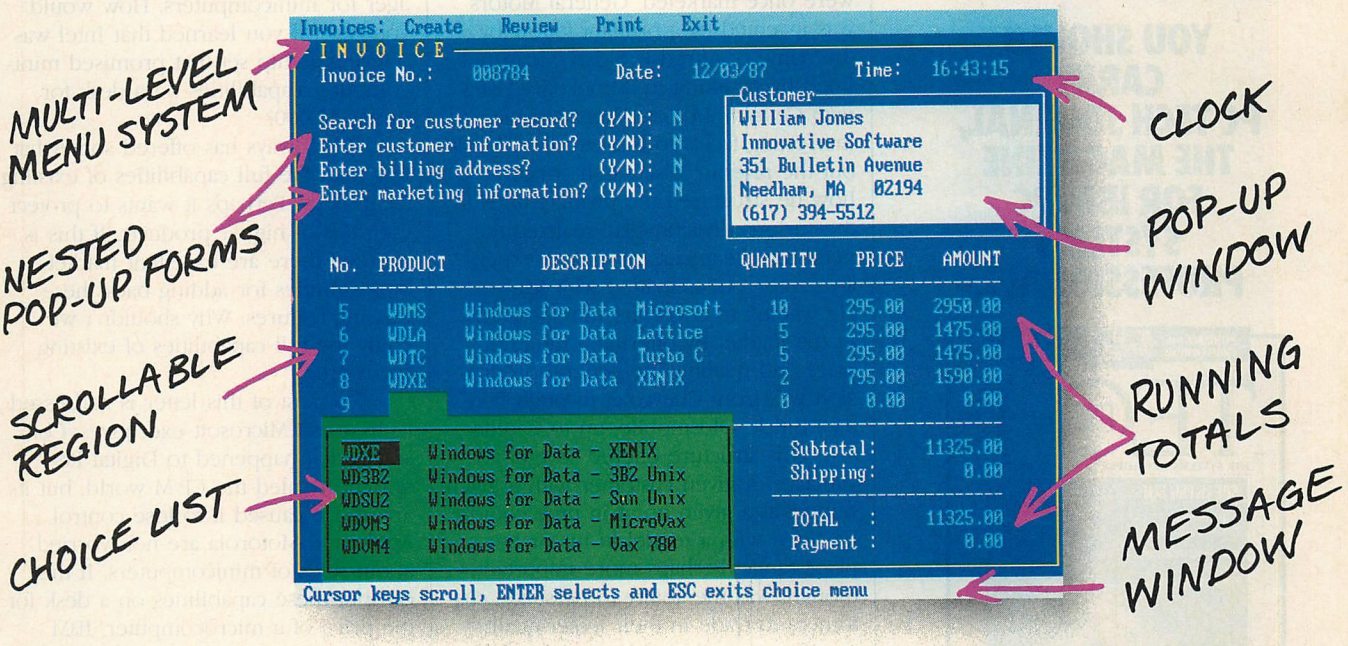
A lot of paper and ink have been invested regarding IBM, PS/2, Microsoft, OS/2, and so on. Despite your excellent coverage of these topics, confusion still exists in some quarters as to where the PC world is heading. The question I am struggling with is *why*? Why doesn't OS/2 support multiuser capabilities? Why is the Model 50 disk so slow? What makes IBM tick?

Such questions would be easier to answer if we had a model for IBM's

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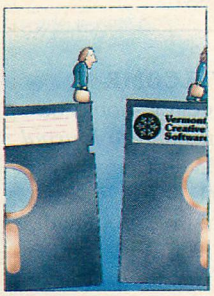
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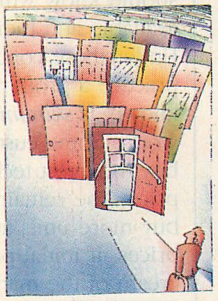
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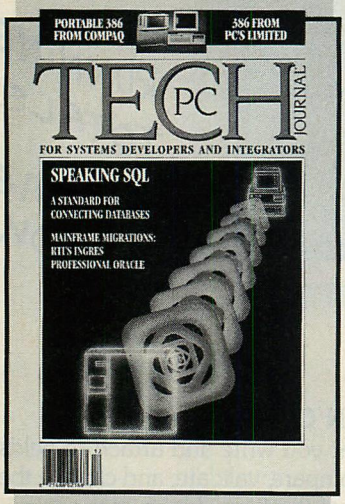
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marketing philosophy. Because IBM is calling the shots, it would be easier to play their game if we knew the rules. Here is one person's stab at it.

Consider the way automobiles were once marketed. General Motors was invented by a brilliant fellow by the name of Alfred P. Sloan. Sloan outlined his thinking in a book, *My Years with General Motors*. There are many interesting facets to this excellent book, but the relevant discussion concerns how he structured the product lines in the various divisions. He realized the need for cheap cars as well as expensive automobiles loaded with features. He wanted to cover the full spectrum of the market by offering a range of price and quality. The general progression was from Chevrolet through Pontiac, Buick, Oldsmobile, up to Cadillac.

This structure offered several advantages. A given customer with a given budget at a given point in time could be fitted with a model in his or her price range. Perhaps more important, though, was the ability to persuade customers to trade in their lesser-quality cars for more desirable models. This trade-in feature was so important to General Motors, that it instituted the expensive ritual of annual model changes. The parallels with the PS/2 line should be obvious.

Now, let's discuss possible pricing strategies for new products. IBM effectively has an unlimited advertising budget. All potential computer customers should know which IBM products are available and their relative prices. Under these conditions, a company can practice a profit-maximizing strategy known as *skimming*. Here is how it works. Some customers can afford to buy the latest technology whatever the price. The remaining customers will buy more units at progressively lower prices. If initial prices are high, the cream of the market will soon own the product. If a manufacturer then lowers prices gradually, more people will buy as the price reaches their bracket.

This strategy is partially financed as manufacturing slides down the learning curve. The theory is to persuade each customer to buy at the maximum price he or she is willing to pay. Just before a product completes its life cycle, more-capable products are offered and the cycle repeats itself. This strategy is effective only for new products. A manufacturer of low-cost products can enter a mature market with aggressive pricing in order to squeeze the competition.

We should not forget that the microcomputer is not the end of the line for IBM. It also builds workstations, minicomputers, mainframes, and so on. Suppose you are the IBM product manager for minicomputers. How would you react if you learned that Intel was offering a chip set that promised minicomputer capabilities on a desk for under $5,000?

IBM always has offered somewhat less than the full capabilities of existing technology. Perhaps it wants to protect the sales of higher products. If this is so, then there are excellent market opportunities for adding back these missing features. Why shouldn't we enjoy the full capabilities of existing hardware?

The rest of this letter is addressed to IBM and Microsoft executives. Consider what happened to Digital Research. It ruled the CP/M world, but its arrogance caused it to lose control. Apple and Motorola are not worried about sales of minicomputers. If they can put these capabilities on a desk for the price of a microcomputer, IBM could lose both markets. Listen to the complaints you read on these pages. These are your customers talking. Design and build the best combination of hardware and software that current technology allows, price it fairly, and let the competition worry about you.

William L. Bassett Jr.
Clearwater, FL

ERRATUM

We regret an error in the item on Borland International's Prolog 2.0, (Tech Releases, August 1988, p. 49), which said that Turbo Prolog users can upgrade to version 2.0 at no charge. The cost to upgrade for registered Turbo Prolog users is $64.95 plus a $5.00 shipping/handling fee.

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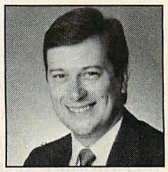
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NEW DIRECTIONS

Future of Software Engineering

Software developers still lack many advantages of the engineering disciplines. □ Also, SIGGRAPH '88; and processor projections.

On many occasions in these pages, I have written about the topic of software engineering and development. For the most part, my comments have been directed at particular, isolated issues relating to programming or design. What I have never done is collect all those thoughts into a coherent view of where software engineering needs to go. I am going to do that here, because I think it needs to go somewhere better—and soon.

First, you must understand my bias, which of course relates to my background. I was a professional systems developer for about ten years, primarily for realtime, transaction-processing systems, and was also responsible for the company's proprietary operating systems and software-development tools. I have been involved in every phase of the development process, from conception to installation, and worked in just about every capacity from junior programmer to project leader, manager, and beyond. It is a process I understand well.

It also is a process that is in dire need of improvement.

Software development has not changed in any fundamental way in the last 30 years. No matter how adorned with computer-aided systems engineering (CASE) tools or automatic code generators or debuggers or documentation tools or faster machines, the actual implementation phase of the total software development effort still involves edit/compile/link/test in a seemingly endless loop until the project is finally complete.

Yes, developers today are probably more productive than developers were 30 years ago. Yes, all those new and better tools do help. Even so, there are still problems.

We have become more productive developers for several reasons, but they have nothing to do with fundamental methodology. The main improvement in productivity has come from the simple proliferation of computers and their application to software-development tasks. This is nothing more than throwing horsepower at the problem, although it does make a difference. Sixteen years ago it took me at least four hours to get a run back from the campus computing center. Similarly sized projects can be turned around in four *seconds* on the typical 386 system. It is not just that the computers are better and faster—the editors, compilers, and linkers are better, smarter, and faster as well. If you are a competent coder with a proper design, you can build small projects very quickly today.

So what are the problems? Why do I say that the software-development process is a disgrace? And what makes the process different from other engineering disciplines?

The major problem is complexity. Production software built to solve today's specific business problems does not consist of just one isolated program solving one isolated problem. The problems often involve several departments of a company, vast amounts of data of staggering variety and complexity, and diverse users with differing requirements (even for the same application). The solutions are thus very large and extremely complex, even to the point of requiring new algorithms or perspectives on the problem, its process, or its data. Further complicating the issue is that any new application needs to mesh cleanly with *existing* applications and *existing* data sets.

Complexity breeds a maze of detail. Detail is the programmer's bane, but that is not unusual. All engineering disciplines are faced with the problem of huge numbers of details. The problem with software development is that it has not evolved into an engineering discipline at all, and may actually never make it to that point.

If you examine other engineering tasks, you will find a carefully structured process that has endured for centuries, becoming especially refined since the industrial revolution. At every stage of a project—building a bridge, for example—the talents of different people are used to best economic advantage. In the case of a bridge, outside authorities state the requirement, architects or engineers conceive the design, engineers figure out how to build it, and, finally, construction workers actually build it.

Except for stating the requirements, every stage of the software-development process requires experts

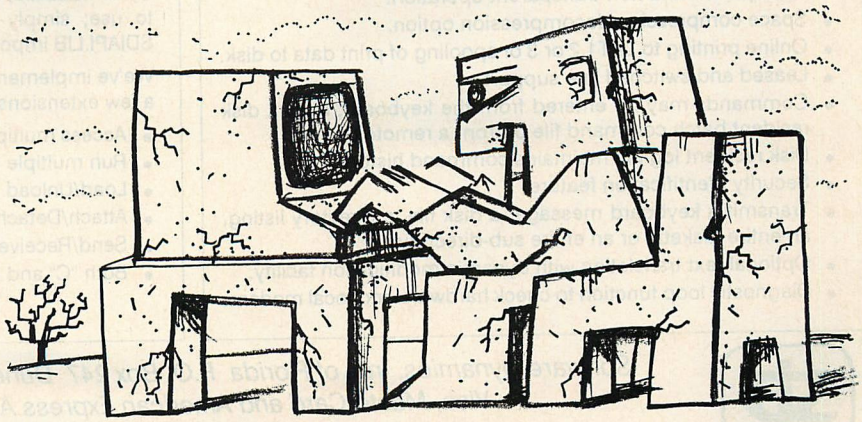


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with training and experience in computer science and information processing. At the design and specification stages, the architect (systems designer) or engineer must understand what computer systems can do and how they do it in order to propose a feasible design. (Although some systems analysts have never been programmers, that is the exception rather than the rule.) When the design and specification are complete, the task moves on to programmers—the actual builders—who are also trained, knowledgeable computer scientists. In fact, one of the reasons that software development is such an expensive proposition is that the players are generally college-educated people who consider themselves professionals and demand salaries and lifestyles appropriate to their training and experience.

Because these people have very much the same skills and training, software development has not become a typical engineering discipline. In other disciplines, engineers must be licensed to private practice, and tradespeople follow their blueprints.

In a sense, a bridge builder is a worker who knows how to "use" steel and concrete, how to put such materials together to form the object represented by a set of design documents. Experience may tell him that a particular truss looks weak, but he will not be able to prove it. Unless he can be proven to have performed his work negligently, such a worker also is not liable for damages if the bridge collapses—society places the blame on the designers and engineers.

Society, however, has been unable to draw a similar line between the engineering of software and its implementation. We might claim that the software-development process could be forced into the same kind of situation by creating a stratum of people with special qualifications to be the "engineers." The problem is that the "workers" still need to have the same kind of education, training, and experience as the designers to implement software solutions. Differentiating between designers and coders is difficult because the criteria are so subjective and involve creativity and insight.

The fact of the matter is that software development is a much different kind of activity than traditional engineering. It requires considerable intellectual resources at all levels of the process and involves a staggering amount of detail, both in the command of facts (like the application program interface for OS/2 with Presentation Manager) and the understanding of the design requirements, which for larger projects can fill volumes. Software development also involves a process that is not typical of engineering: the translation of nonprocedural design concepts into procedural source code to yield the desired effect.

This translation process creates a second problem in software development. Once the code is written, it may not connect very well with the original design information. We can look at an elevation of a bridge, then the finished bridge itself, to see that the physical object and its design representation match. We can do the same with electronic devices, although sometimes the components can be somewhat abstract (one chip can provide circuitry to many different parts of the design, for example). Except for the visible parts of a software application, such as the screens and reports, it is hard to determine that the program is equivalent to the specification.

Our industry has tried for years to apply the same kind of engineering methodologies that have worked so

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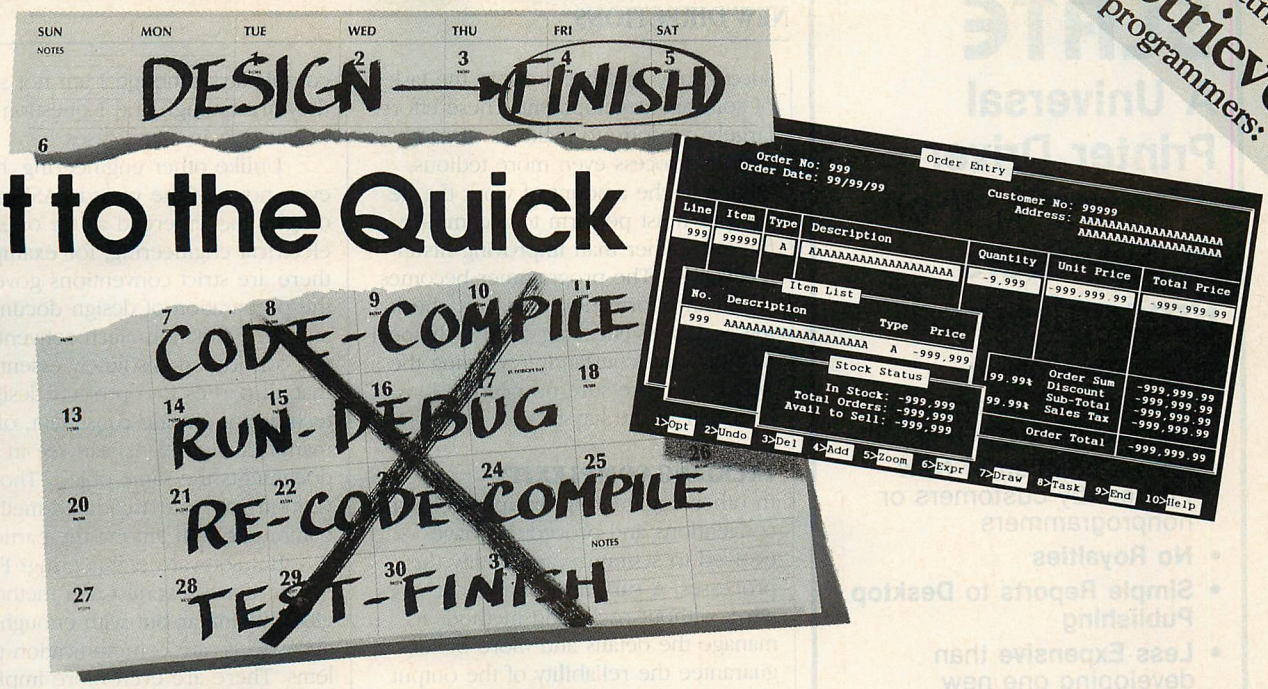


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successfully in other areas to the task of software development. These efforts largely conspire to make an already tedious process even more tedious, adding to the amount of work the developer must perform to accomplish the task rather than improving his effectiveness. The programmer becomes a human information manager, checking and cross-checking code with specifications and constantly reviewing the details to make sure no needles have been left in the haystack.

TACKLING COMPLEXITY

In other engineering disciplines, useful conventions and procedures have evolved to systemize and codify the processes. A survival instinct is at work here; without rock-solid methods to manage the details and more or less guarantee the reliability of the output (for example, a bridge that won't collapse), our society never could have made so much progress.

When computers came along, they did not so much revolutionize engineering as they improved the efficiency and productivity of engineers. In other words, the methodology did not change. Automating those same methods simply allowed them to become faster, more reliable, and less costly.

Where are those productivity enhancers for software developers? I claim they have not arrived, perhaps for good reason; today, however, we are poised for some improvement. The delay may be due to underlying technology. For example, CASE tools have shown us that considerable resources are required to assist the software developer; 11 years after the advent of the personal computer, such tools are only just beginning to appear on the desktop. Another reason for the delay may be more telling—we may not know how to systemize and codify the software-development process.

Some attempts have been made, most notably in the design area. CASE is the result of a comprehensive body of work in systems design (see "The CASE for Structured Development," Carma McClure, August 1988, p. 50). CASE tools, which aid developers with automation during all phases of a project except implementation, have achieved respect and a reasonable level of success. New versions of these tools are beginning to tackle the very difficult problem of automatic code generation to fill the last gap. CASE tools are the only attempts so far to solve the entire set of problems and manage the complexity, although I am not sure they are enough and I question their orientation in some cases.

Unlike other engineering, however, none of the varied CASE methodologies has emerged as *the* one. In electrical engineering, for example, there are strict conventions governing the preparation of design documents and their notation. Such conventions are considered absolutely essential so that all parties to a project (designer, technician, outside consultant, offshore manufacturing plant) can see in the documents the same object. Those conventions provide a codified method of communication among the parties.

But software engineering? Forget it. There are several CASE methodologies, all similar but with enough differences to create communication problems. There are even more implementation languages, confusing the issue further. Ask an experienced C and COBOL programmer to exchange code—then watch them pull their hair out trying to understand each other.

Without clear standards, it will be next to impossible to codify and therefore systemize the entire software-development process. It also will be impossible to turn software development into an engineering discipline.

A POSSIBLE DIRECTION

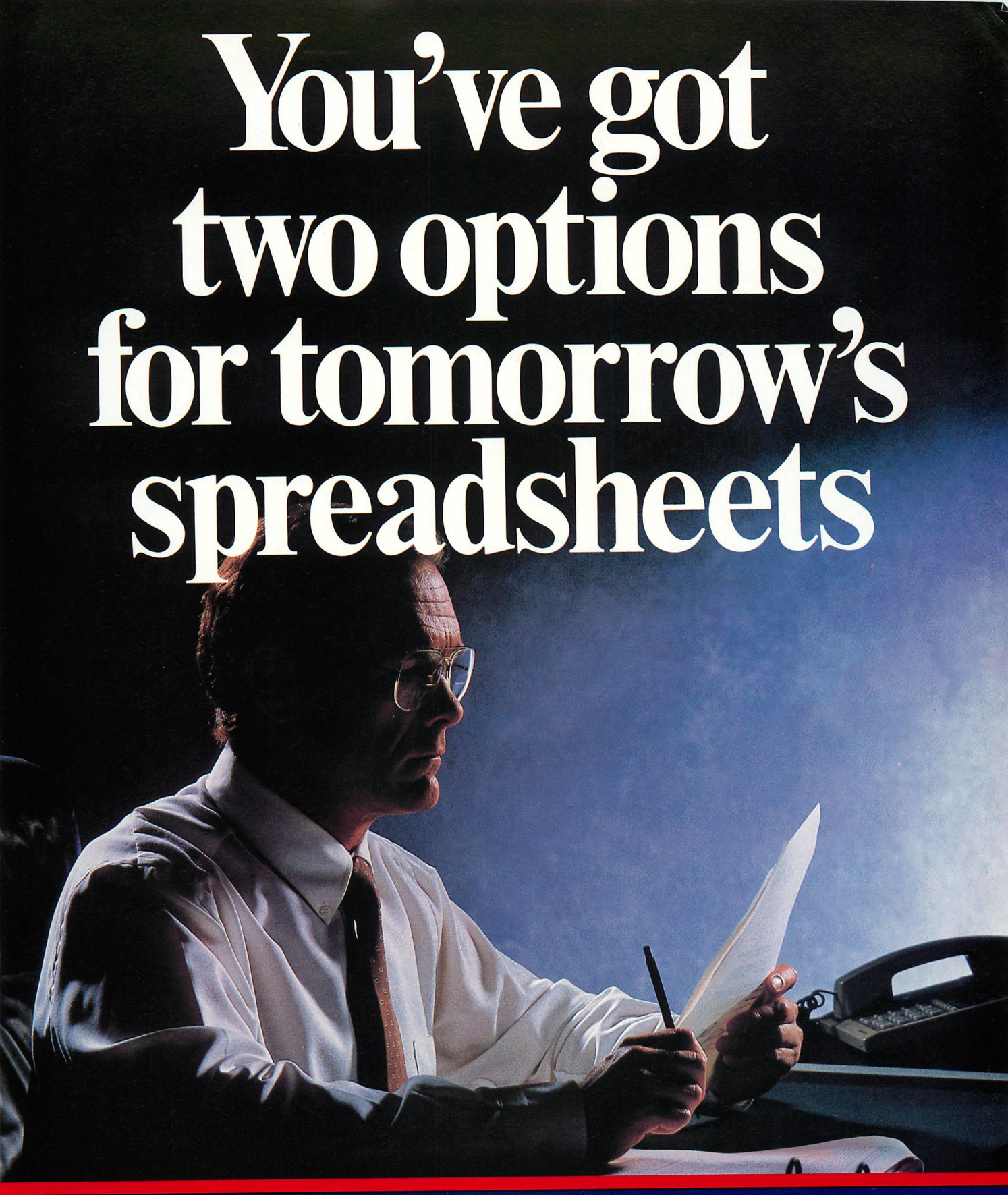
I do see a way for software engineering to move forward—would I have wasted our time otherwise?

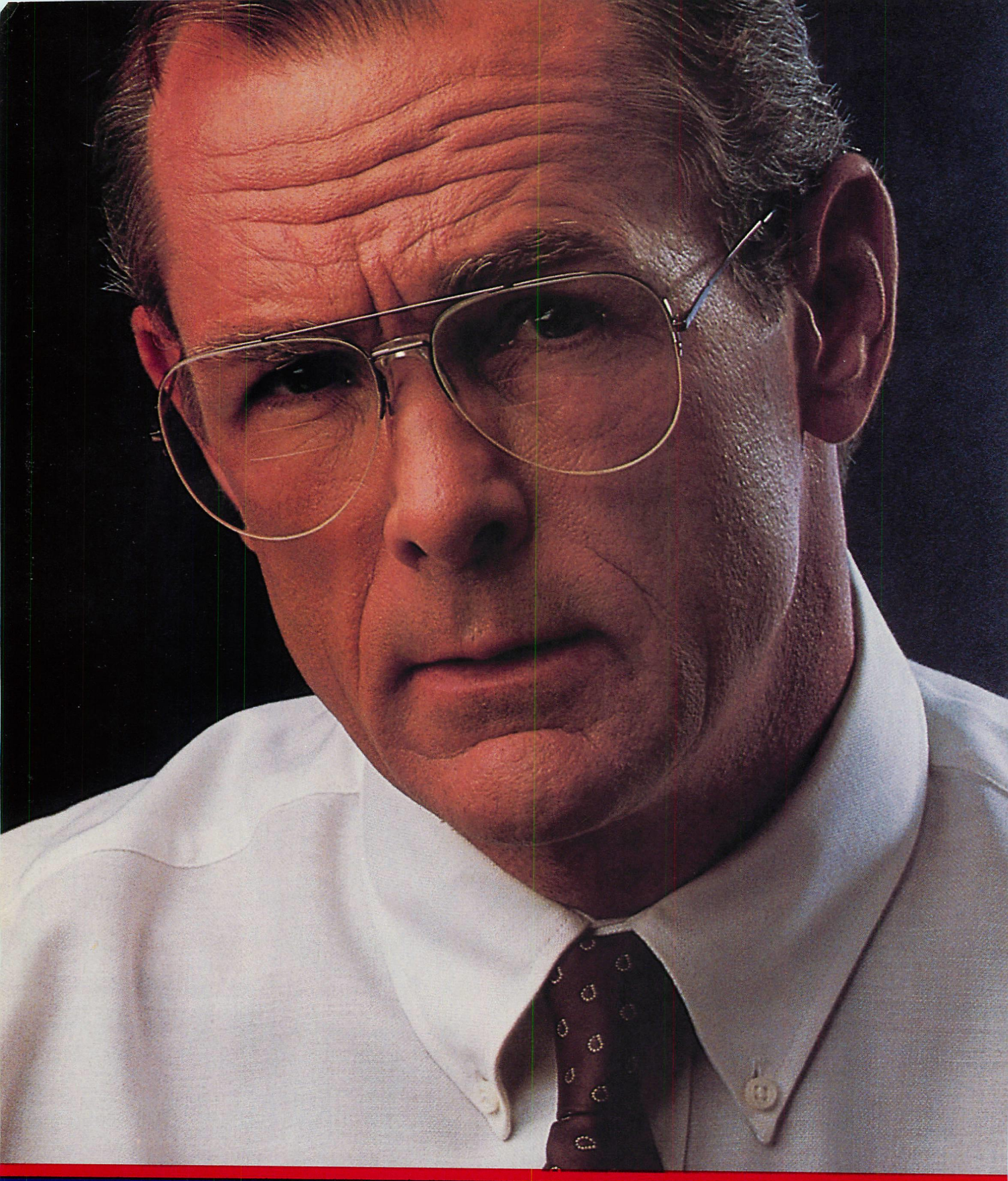
Let's explore, for just a moment, what we are likely *not* to do. We will not give up our favorite programming languages, at least not right away. Nor have we seen the ultimate language, one we will start to like and actually use. The same goes for design methodologies—you may like Martin, and I refuse to budge from Jackson. We will not give up our own procedures, if for no other reason than the time it has taken us to get here or because intellectual processes are characterized by individual, personal differences.

The computer itself can be turned to that problem, however. What we need is not a process that imposes its own order upon us, but one that takes our notion of how the work should be done and supports us in the endeavor. What we need is a developer's assistant, a software system that will scurry around, watch all the details, and tell us when we are being ignorant or even stupid. Let me call this concept the automated integrated developer's environment, or AIDE.

Continued on p. 31

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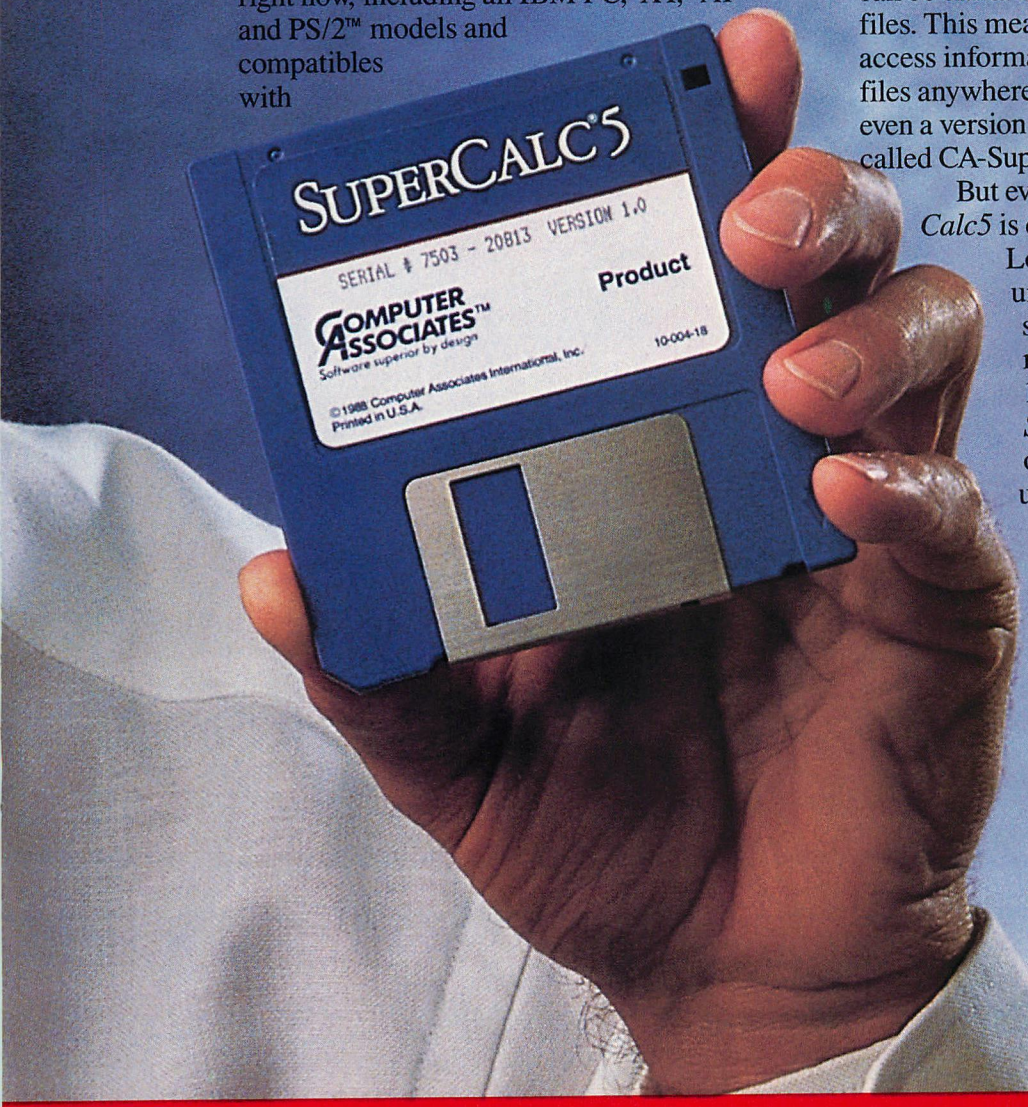
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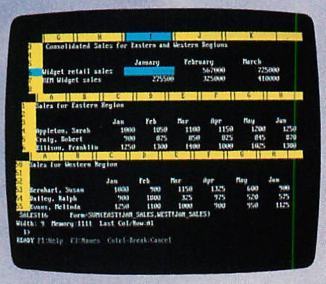
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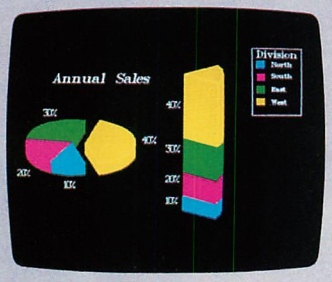
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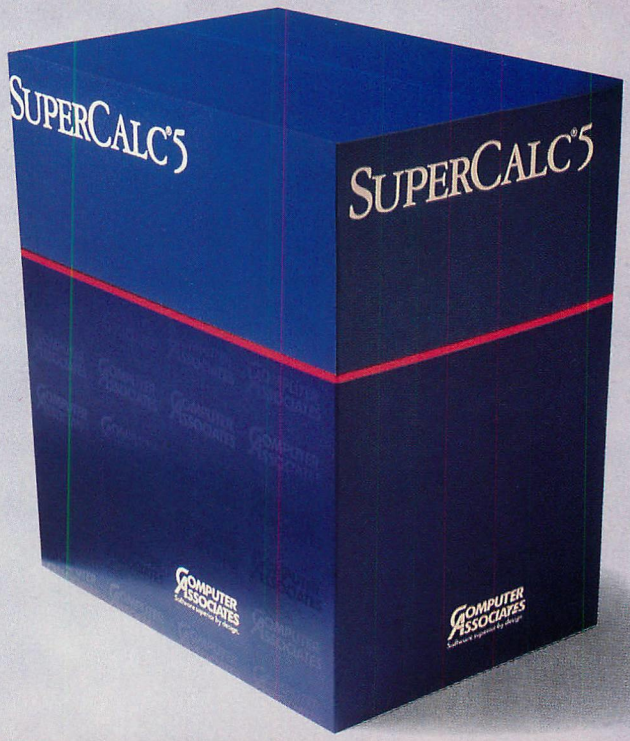
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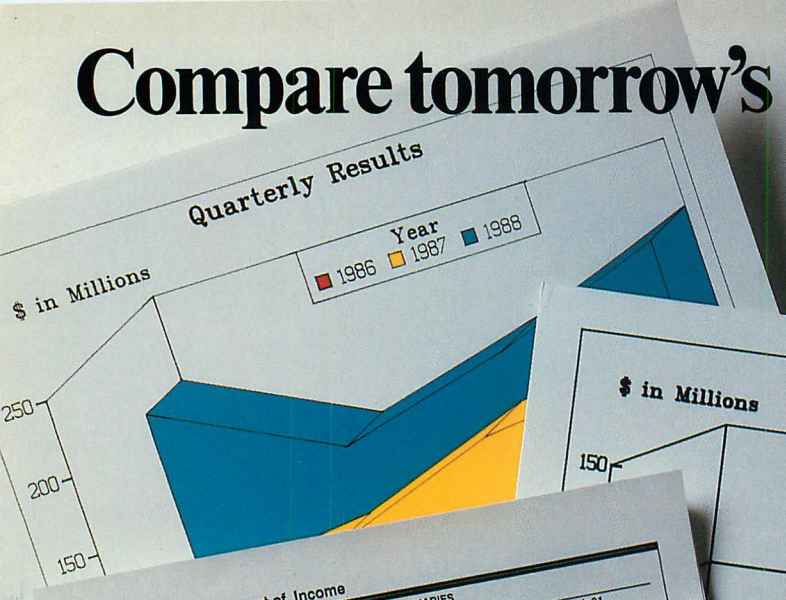


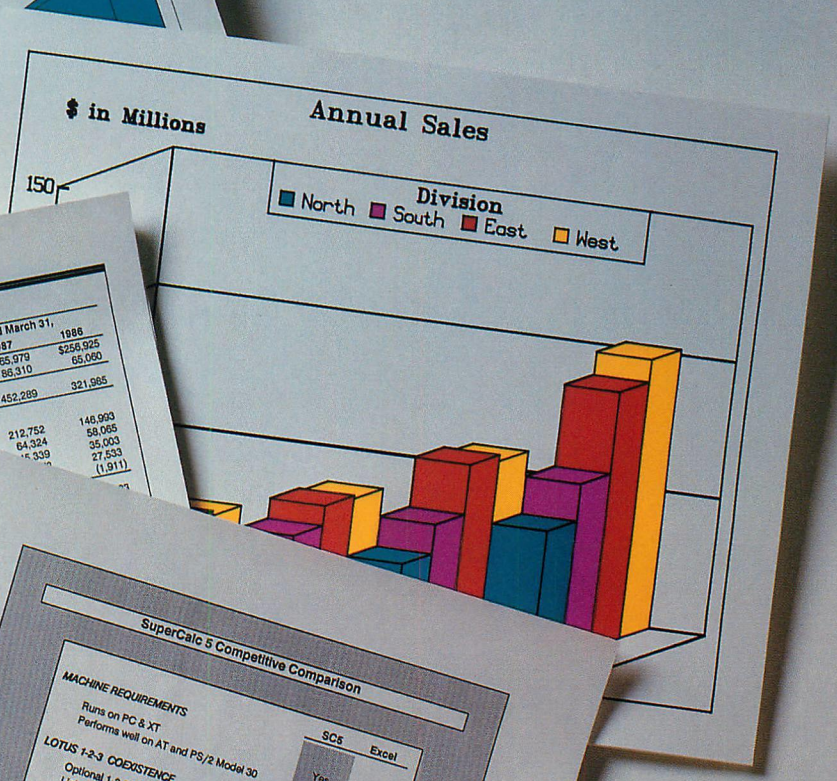
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Consolidated Statement of Income

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(Dollars in thousands except per share amounts)	Year Ended March 31, 1988	1987	1986
Product revenue and other related income	$542,730	$365,979	$256,925
Maintenance fees	166,379	86,310	65,060
TOTAL REVENUE	709,109	452,289	321,985
Costs and expenses:			
Selling, marketing and administrative	335,811	212,752	146,993
Product development and enhancements	81,469	64,324	58,065
Commissions and royalties	65,667	15,339	35,003
Depreciations and amortization	58,48		27,533
Interest income, net (Note 5)	(2,8		(1,911)
TOTAL COSTS AND EXPENSES	53		
Income from continuing operations before income taxes and extraordinary credit			
Income taxes (Note 7)			
Income from continuing operations before extraordinary credit			
Loss from discontinued operations			
Income before extraordinary credit			
Extraordinary credit			
NET INC			
Income (loss) per common share:			
Income from continuing operations before extraordinary cr			
Discontinued operations			
Extraordinary credit			
NET INCOME PER CO			
Weighted average common shares used in compute			
Income (loss) per common share assuming full d			
Income from continuing operations before ex			
Discontinued operations			
Extraordinary credit			
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Weighted average common and comr used in computation (Note 1)			

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See Notes to Consolidated F

SuperCalc 5 Competitive Comparison

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Performs well on AT and PS/2 Model 30	Yes	No
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Optional 1-2-3 Menu and Macros	Yes	No
Link to 1-2-3 Files	Yes	No
MULTISHEETS WITH LINKS		
3-D Spreadsheets (Pages)	Yes	No
Linked Sheets in Memory	Yes	No
Dynamic Links to Sheets on Disk	Yes	No
Spreadsheet "NickNames"	Yes	No
DEBUGGING AND AUDITING FEATURES		
Comprehensive Debugging and Auditing	Yes	No
Auto Step-Through Macros	Yes	No
Map ("Birds Eye") View	Yes	No
PRESENTATION QUALITY REPORTS		
Complete Laser Printer Support	Yes	No
Fonts, Shading, Boxes, Grids, Lines	Yes	No
Automatic Double Underlining	Yes	No
PRESENTATION QUALITY GRAPHICS		
Production Quality Graphics	Yes	Yes
3-D Bar, Pie, Area and Line	Yes	Yes
Curve Fitting	Yes	No
OTHER FEATURES		
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Memory Save - Eliminate Formula Duplicates	Yes	No
Auto Link to LAN Devices	Yes	No
IBM Mainframe Version Available	Yes	No



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What will make AIDE possible? First, AIDE needs loads of information. The OS/2 API is a good example because it is large and rife with detail. AIDE's information base on the API would include not only what the function calls are, but also what they do. This does not mean information just for the developer, but information AIDE could digest as well. Thus, it could suggest an existing OS/2 function after you have provided the description of one you were to write from scratch.

Next, AIDE needs to learn about your preferred methodologies. It needs to know you are a Yourdon advocate and that you are using C++, some assembly language, and a touch of Prolog. It needs to read and understand the stored documents from the CASE tool as well as program source code, object files (which contain lots of information besides code), linker output files (ditto), and any other data associated with the development process. You might have to teach AIDE some of these tasks, but more likely toolmakers would provide data description files to describe such objects to AIDE in detail.

Now, here comes the hard part. AIDE needs to connect all the pieces together, not just by some limited association such as the presence of a file name in a MAKE file, but in much broader, complex terms.

Suppose you are writing a piece of code to handle a simple situation in a Microsoft Windows program. You have to write the code that handles the dialog box for a File Open sequence. AIDE has a design database that contains the requirement—it knows the particular menu activity that invokes this dialog, knows where the dialog is to be placed in the window, and knows the nature of the process to be invoked as a result of the file being opened.

In addition, AIDE knows about some previously written or provided code that creates such dialog boxes. First, AIDE might suggest calls to that standard code, which you decide to accept; you provide any special parametric information (opening the dialog for a particular directory, for example). You then decide that you are done, but AIDE warns you that the specification calls for the opened file to be displayed on the screen and that you have not provided code to do so.

That last sentence contains an important implication: in order for AIDE to know that you have provided code to address a particular specified requirement, you must encapsulate source code within descriptors that provide enough information for AIDE to make the necessary connections.

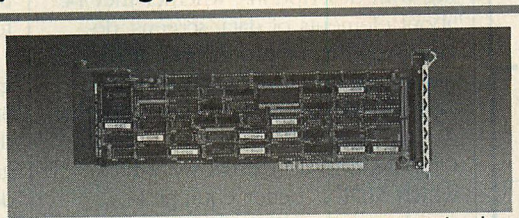
These descriptors are important for another reason: they allow AIDE to find the code later—even if you have forgotten that you wrote it—to meet another specified requirement. AIDE would find the code based on its understanding of what the code fragment does, which is hard to infer from the code itself.

That means that source files ultimately must consist of more than just program code and comments designed to guide the programmer instead of providing lasting documentation. AIDE needs to keep a complete and detailed database on every item in the system to maintain the connections between the specification and the program and to keep track of all the details in the program itself. That is a lot of data, enough to overwhelm a human programmer but nothing more than light exercise for a computer.

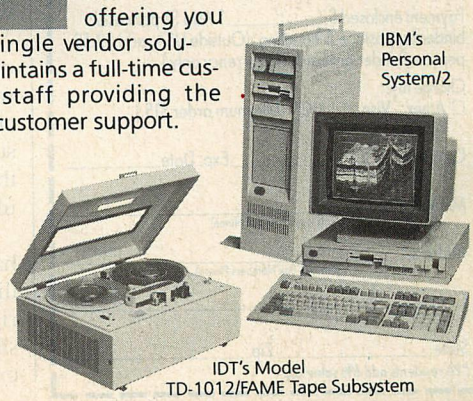
Most of the tedium in the development process comes from the constant need to do similar tasks over and over. How many FOR loops have you written in your career? How many BEGINs and

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ENDs (or left and right parentheses) have you filled in? How many times have you gone back to Computer Science 101 to produce a basic, simplistic piece of code? Too many bloody times, I say. One of the problems with procedural languages is that they force us to do so. Thus, AIDE is not practical unless it is coupled with a nonprocedural programming environment. The object-oriented languages available today provide some clues about what such a language could look like, but even they are primitive compared to what AIDE might require.

This does not conflict with the use of C or COBOL, because AIDE will also be able to translate its results to whatever language you prefer, including the one with the best optimization. Of course, that also means AIDE could skip the translation step and generate its own code, perhaps with an installable code generator that could be replaced as the technology got better or in the event that the underlying instruction set changed.

AIDE could go even further by allowing you to dirty your hands with a direct piece of coding work, although its built-in professional ethics might require it to warn you that it cannot accept responsibility for such work and even demand that you sign a waiver. (I wonder if AIDE could be held liable for any damages?)

AT WHAT COST?

There is a trade-off here. A tool this sophisticated requires an upscale machine; an old PC just won't do. It also requires the developer to stop working with the details of the machine and its procedural languages and begin working with descriptions, whether they be about elements of data, screens, devices, reports, or procedures. It requires the developer to work in concert with design tools, to use a specific design methodology, and to resist the temptation to do menial work for which AIDE is better equipped.

In return, AIDE adapts to your way of working, handles all the details, warns you about errors or inconsistencies, and generally does its best to assure that the design is correct and that the resulting program meets the particular specification.

Can it be done? Yes, because we have sufficiently powerful hardware for the desktop in 386-based machines, the right operating system in OS/2 (or possibly UNIX), and a growing base of experience in expert systems on such platforms. Expert-system technology is, of course, a key element for any tool of AIDE's complexity.

Will it be done? Frankly, I am not optimistic. The emphasis today is still oriented toward supplying tools that improve the existing processes, much as tools *have* improved other engineering disciplines. My argument is that building software is different, and that it will require sharply different tools if we are to progress toward the goal of better automating the developer.

Sometimes, society tolerates costs if our goals are lofty or the need is great. We are tolerating high costs and primitive methods in software today because we must. However, we need to recognize that those labor-intensive costs are still rising and that the development process is not as codified as it is for other disciplines, and therefore is inherently unreliable. We also must recognize that our ability to produce software is a vital national resource because information systems hold the key to our future.

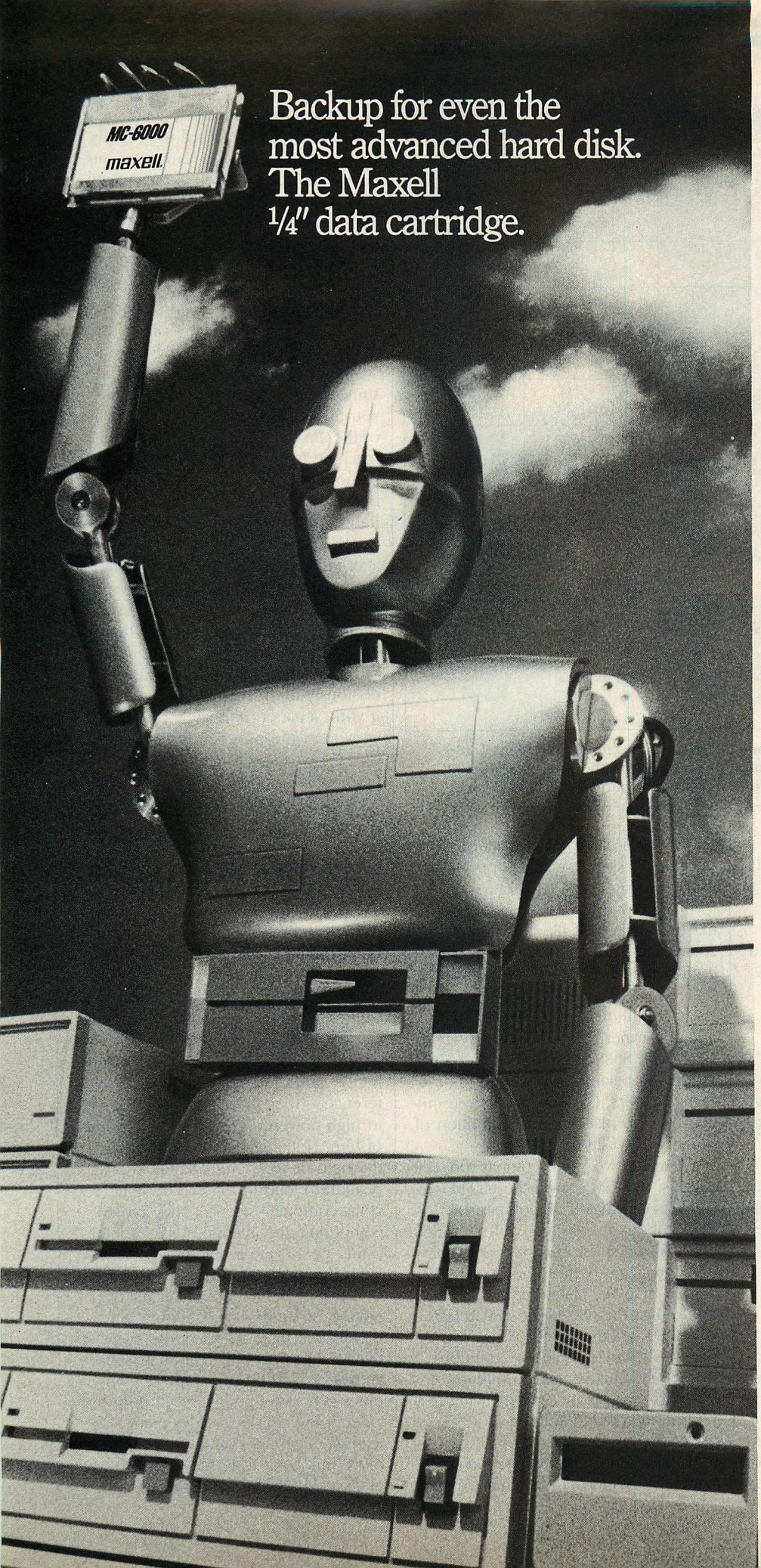
Maybe AIDE is beyond our current abilities. Perhaps desktop computers are still underpowered for this task. Nonetheless, *PC Tech Journal* will keep looking for signs of progress. Let us know if you see any.

THE FUTURE OF WINDOWS

I have recently been pondering the nature of the desktop computer market for the future. We have all read in the trade press that the Macintosh is making steady inroads into Corporate America, gaining significant market share. We also have heard that the supply of the next generation of chips, the 80386 family, is limited as Intel works to fire up new manufacturing capacity.

But is the Macintosh really gaining ground on the PC? How many 286 and 386 machines can we expect to see on desktops over the next few years? Will graphics user interfaces such as Windows and Presentation Manager really prevail? Where should our valuable (sometimes scarce, but always expensive) software-development energies and resources go? For a magazine such as *PC Tech Journal*, the answers to these questions are important because they give us clues about how we should target our future coverage.

Trying to get these questions answered has been frustrating because they all hinge on who will sell what hardware over the next five years, and this information is tough to come by.



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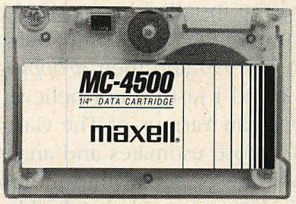
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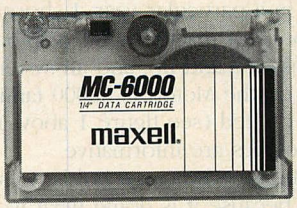
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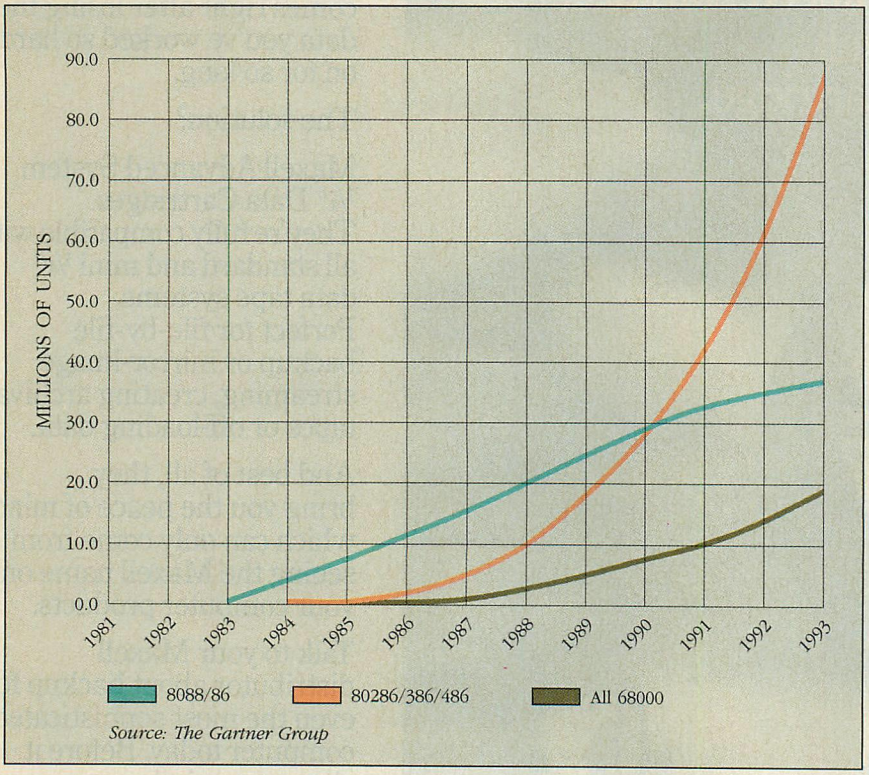


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FIGURE 1: ***Installed Base of Intel and Motorola Processors***



Projections from The Gartner Group indicate that the installed base of Intel 286/386/486-based systems will far outdistance those based on the Intel 8088/86 and those based on the Motorola 68000 family by the early part of the next decade.

This type of data from any source is usually sheer speculation. Information from most of the major research houses has been inconsistent. In one case, a projection from DataQuest showed the installed base of 286-based desktop computers peaking at about 9 million in 1990 and then *dropping off*—a trend I just cannot believe.

Jonathan Yarmus of The Gartner Group, whose estimates and analyses are highly respected within the computer industry, provided me with data through the year 1993. They proved to be fascinating reading.

The interesting number is the installed base of a particular class of machine in a particular year. I chose three categories of machines: 8088/86-based systems, 286 and up, and all systems based on the Motorola 68000 family. When plotted (see figure 1 above), all three curves are informative.

The 8088/86 curve holds no surprises because it is doing what we all probably expect. The rate of growth of the installed base starts to taper off beginning next year. Gartner estimates the installed base of these machines to be about 20 million units by the end of this year and 36 million units by 1993. That sounds like a lot of machines representing a sizable market opportunity in its own right, but read on.

The curve for 286, 386, and 486 machines takes off like a rocket. According to Gartner's projections, about 9 million such machines will be installed by the end of this year, with about 8 million of those being 286-based. Gartner projects a crossover in 1990, with 8088/86 machines and 80*x*86 systems in balance at about 27 million each. By 1993, Gartner predicts 86 million units in place, about 50 million of which will be 286s.

I made two other comparisons. Pitting just the 286 against the 68000 (a PC/AT to Macintosh SE comparison) shows about a 4:1 ratio, with 20 million 286s versus 5 million 68000s in 1990, growing to 50 million versus 12 million by 1993. Matching the 386 and 486 against the 68020 and 68030 (PS/2 Model 80 or other 386 box against Macintosh II) yields about 7 million 386/486 systems versus 1.6 million 68020/30 systems in 1990, growing to 37 million versus 7 million in 1993.

If the numbers are true, they could have enormous impact on the market for Windows, Presentation Manager, and their derivatives. With such projections, it is not hard to see why Microsoft is pushing its environments so aggressively and why so many software vendors are throwing their hats into the ring (see New Directions, Will Fastie, September 1988, p. 23). At the same time, this projection shows systems based on the 286/386/486 outselling all 68000 machines (including Macintosh, workstations, and Commodore Amigas) by a factor of four to one.

Given such a projection, and assuming you believe it, where would you put your development dollars? Part of the answer is to target whichever machine is being used in the particular niche into which your software falls. A bigger part of the answer, especially in light of the dwindling difference between a Windows- or Presentation Manager-equipped PC and a Macintosh, is how many machines of each type are in your target base of users. Without significant differences between the two environments, the system type holding the majority of the installed base is obviously the primary objective, even if your situation ultimately demands a version of the program for both camps.

If I were starting a software company today, though, it would be very hard to ignore The Gartner Group's predictions for the Intel family.

ANIMATION WONDERLAND

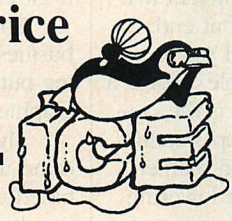
One of my favorite exhibitions of the year is the Annual Conference on Computer Graphics and Interactive Techniques, popularly referred to as SIGGRAPH. Sponsored by the Association for Computing Machinery's Special Interest Group on Computer Graphics in cooperation with the IEEE Technical Committee on Computer Graphics, the conference is mecca for anyone interested in high-powered graphics and an oasis of film, video, and art produced with the help of computers. SIGGRAPH is a beautiful blend of high technology, serious computer science, and applied computing; the attendees are an interesting mix of techies and artists (the latter being the end users).

SIGGRAPH '88, held in Atlanta in August, continued the tradition. Although the main thrust of the event over the past several years has been animation and the marriage of computer-generated graphics with film or video, the exhibit provides many leading-edge clues about where the more mundane tools for business graphics might be headed.

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Dr. Dobb's Journal — May 1988

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CIRCLE NO. 155 ON READER SERVICE CARD

While at SIGGRAPH, I wanted to see if Microsoft Windows or Presentation Manager (or even Apple Macintosh) was making an appearance, and to what extent off-the-shelf desktop computers were being used in this world. I also wanted to see what display standards were emerging to get a clue about the successor to VGA.

In this market so far, the PC is all but invisible. I saw no products based on Windows or Presentation Manager and only one or two based on the Mac. Most of the systems ran on workstations, usually Sun, Apollo, Tektronix, or DEC, but sometimes a proprietary solution from the vendor. The most popular approach is an imaging system that uses the workstation as a front end.

The few Macs and PCs I saw were performing this front-end role. This is a new development and reflects the convergence of high-end desktop systems with the low-end workstation market, with the attendant benefit of lowering the cost of at least one component of an imaging system. As an example, Pixar, one of the well-known names in image systems, announced a lower-cost system that uses a Macintosh II as the front end.

To put it bluntly, the traditional business desktop computer plays nothing but an ancillary role in the big-time graphics market.

My quest for display technology came up almost as dry. Obviously, PC-based display subsystems require PCs, but they were few and far between. Number Nine Corporation was the only company showing display hardware—the SGT Pepper board as well as its other high-resolution products. The component companies, mostly Japanese, were showing their entire range of monitors.

The PC side of the world is lagging behind Macintosh in this regard. Although Apple does not offer a large, high-resolution display subsystem itself, the Mac II architecture smoothly accommodates 19-inch displays such as the SuperMac and Radius, as well as the extra circuitry to drive them. The resolution is high and the support for color is superb. Similar third-party solutions exist for the PC (such as the high-resolution products from Number Nine), but there is no standard, de facto or otherwise.

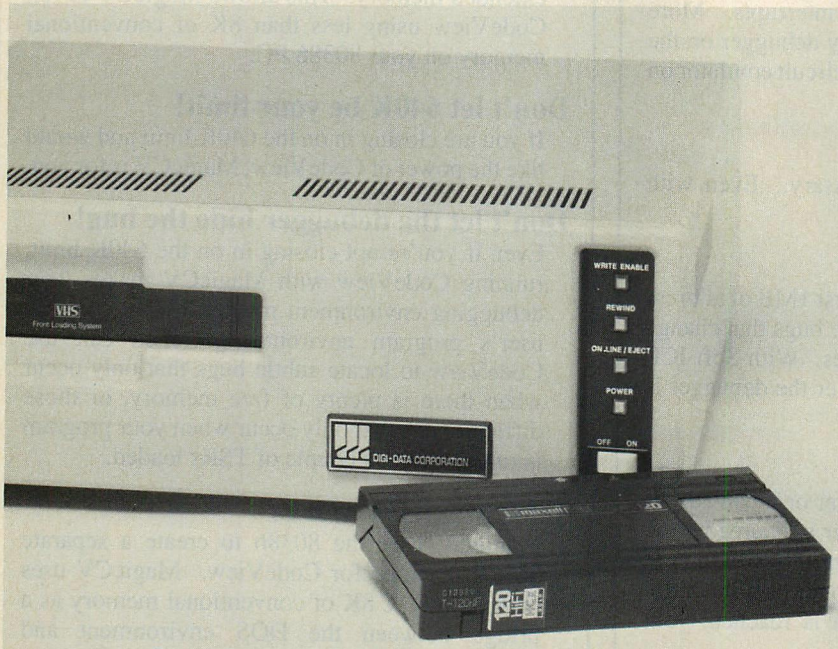
Interest in IBM's 8514/A adapter and 8514 monitor seems to be rising; however, the subsystem lacks the potent color support available on the Mac II, even though the resolution is competitive. No 8514 subsystems showed up at SIGGRAPH.

The exhibit hall was refreshing in one respect—everyone was upbeat about memory availability. Of course, these are vendors who tout the capability of their expensive imaging systems to support more than 100MB of RAM. They talk about 5MB of RAM the way you and I talk about 1MB, and when we top off our 386 systems with 5MB, they are just getting started.

If you have a chance to get to SIGGRAPH next year (it will be held July 31 through August 4, 1989, in Boston), do it. You will get an entirely different perspective on computers and what they can do, and, if you have even the smallest art-appreciating bone in your body, you will thoroughly enjoy the art show, the film and video show, and the smashing animation exhibits.

I always have a good time.

Will Fastie is the editorial director and founding editor of PC Tech Journal.



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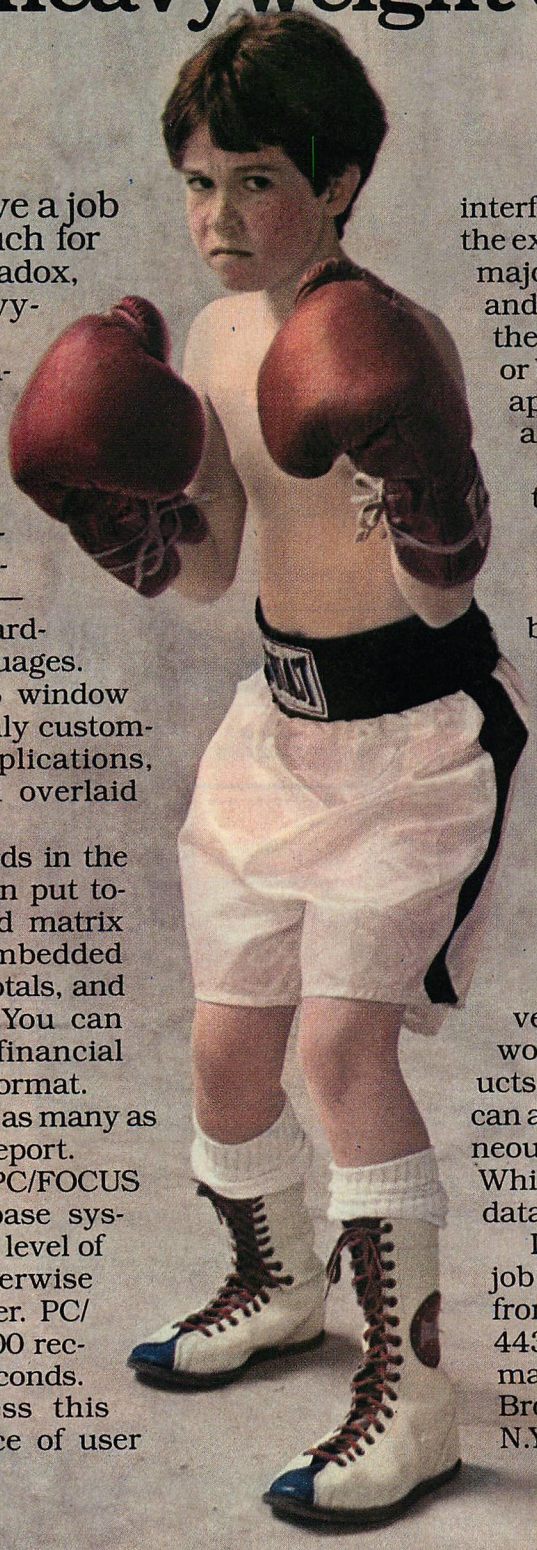
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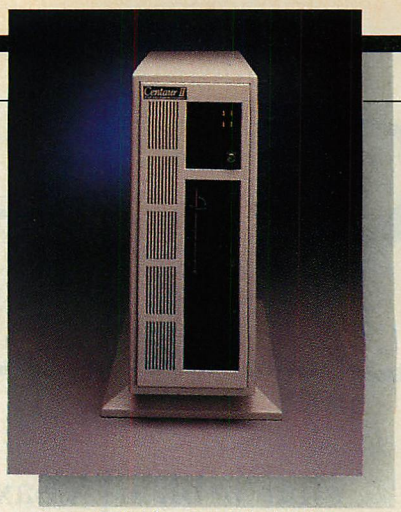
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CIRCLE NO. 156 ON READER SERVICE CARD

TECH RELEASES

The latest in hardware, software, and technology for systems developers and integrators



Centaur II Mini from Data Voice Solutions

SYSTEMS

Two 25-MHz, 80386-based desktop microcomputers are available from **Advanced Logic Research Inc.** (ALR). The **ALR FlexCache 25386DT Model R66** and **Model 100** come standard with 1MB of 32-bit RAM (expandable to 14MB with an optional memory-expansion board that features an automatic memory configuration requiring no switch setting). The ALR FlexCache 25386DT hard-disk drive has an intelligent look-ahead caching controller that transfers data at 650 Mbps with 1:1 interleaving.

Model R66 features a 25-MHz 386 with zero-wait-state memory; ALR's extended emulation 64KB cache system with a 66MB hard-disk drive (30-ms



ALR FlexCache 25386DT

access time); a high-performance controller with full-track buffering; a 1.2MB 5.25-inch diskette drive (1.44MB 3.5-inch diskette drives are optional); and one serial port and one parallel port. Model 100 has the same features as Model R66, except that it comes with a 100MB hard-disk drive. Model R66, $6,490; Model 100, $6,990.

Advanced Logic Research Inc., 9401 Jeronimo, Irvine, CA 92718; 714/581-6770

CIRCLE 303 ON READER SERVICE CARD

An enhanced version of the **Centaur II Mini**, a multiuser, multiprocessor computer system that allows ASCII terminals to run DOS application programs under Novell's Advanced NetWare 2.11, has been introduced by **Data Voice Solutions Corporation**. The Centaur II Mini supports as many as 28 simultaneous terminal users and as much as 628MB of disk storage. Optional features include a 32-bit 386 file processor and multiple application processors that run in parallel and can access DOS applications.

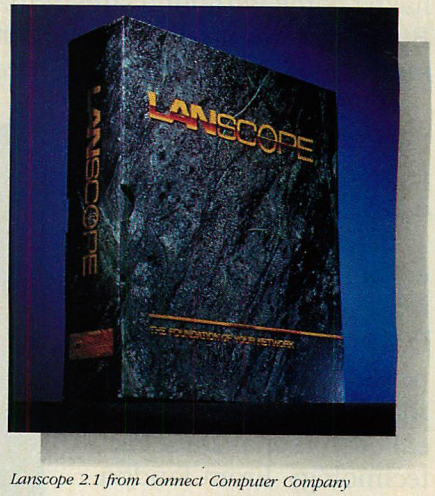
Two application processor cards are available, and both can be installed in the same system. One card has a single processor with one terminal port and one serial port; the other contains four complete application processors (8086-compatible NEC V40 microprocessors), allowing access by four terminals simultaneously. The file and application processors are housed in a central chassis and communicate with each other over a high-speed parallel bus. IBM PC and PS/2 models can be connected to the Centaur II Mini to share system resources. The price for a five-processor configuration supporting more than 20 switched users is from $25,000.

Data Voice Solutions Corporation, One Newport Place, Suite 800, Newport Beach, CA 92660; 714/752-8181

CIRCLE 302 ON READER SERVICE CARD

CONNECTIONS

A network-management system from **Connect Computer Company** provides all essential tools to manage LANs, including Novell NetWare, 3Com 3+, IBM PC LAN, and Banyan VINES. **Lanscope 2.1** offers the security, usage control, print spooling, and other network-management features of the earlier version; enhancements include increased security via the Lanscope Master Administrator Rights Systems (MARS), support for EGA and VGA, printer control via hot-key selection, increased support for three-part naming, support for user-defined constants, and required entry of application software serial numbers. Other features include login tracking and reports, log-



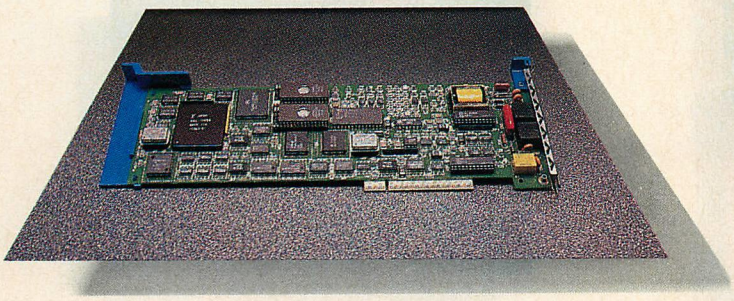
Lanscope 2.1 from Connect Computer Company

ging data protection, and a transparent configuration manager. Lanscope 2.1 includes a foundation module and other modules that can be added to the system. Price per server: Lanscope Foundation, $99; Menu System, $249; Audit Trail: Logging & Reporting, $249; Hot Key Utilities, $199; Turnstyle metering system, $299. Lanscope Complete (includes all modules): one-server license, $495; ten-server license, $395 per server.

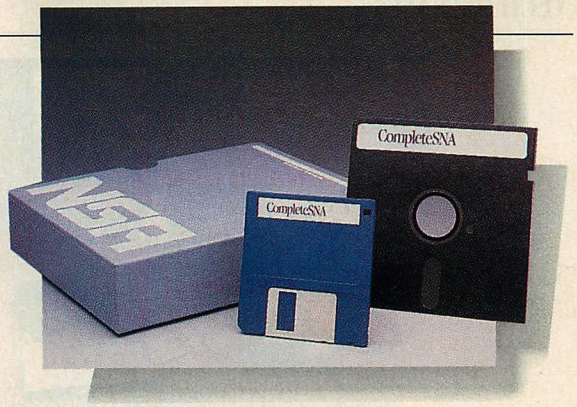
Connect Computer Company, 9855 W. 78th Street, Suite 270, Eden Prairie, MN 55344; 612/944-0181

CIRCLE 306 ON READER SERVICE CARD

Telebit Corporation offers an internal modem board for IBM PS/2 Models 50, 60, 70, and 80 that supports error-free asynchronous communications over ordinary telephone lines at transmission speeds as high as 19,200 bps. The



Trailblazer Plus PS modem board from Telebit Corporation



CompleteSNA from Network Software Associates

Trailblazer Plus PS uses Telebit's patented technology, Packetized Ensemble Protocol (PEP), which enables the modem to divide the telephone bandwidth into hundreds of independent data channels and transmit data across the entire bandwidth of the telephone line.

The Trailblazer Plus PS automatically adjusts its operating speeds and modulation schemes to operate with the existing installed base of 19,200- and 18,000-bps PEP modems and with low-speed CCITT V.22*bis* (2,400-bps), V.22 and Bell 212A (each 1,200-bps), and 103J (300-bps) modems. It is addressable through any of the IBM Micro Channel architecture's eight communications ports and supports the industry-standard command set.

When faced with deteriorating line conditions, the Trailblazer Plus PS adjusts its data rates in 100-bps increments to avoid transmission rate drops found in conventional dial-up modems. Integrated support for Kermit, XMODEM, YMODEM, and UUCP (the AT&T UNIX system communications utility) allows increased speed in throughput and support for off-the-shelf software. Bundled with Hilgraeve Inc.'s HyperACCESS communications software, $1,295; without software, $1,195.
Telebit Corporation, 1345 Shorebird Way, Mountain View, CA 94043-1329; 800/TELEBIT; 415/969-3800

CIRCLE 307 ON READER SERVICE CARD

A communications software package that includes all the major IBM Systems Network Architecture (SNA) protocols has been announced by **Network Software Associates Inc.** Designed for use with the IBM PC and PS/2 models as well as laptops and compatibles, **CompleteSNA** permits switching between interactive, batch, cooperative processing, and program-to-program communications. It allows the machines to communicate with each other and with minicomputers, mainframes, and LAN resources over SDLC, coaxial cable, and asynchronous links. The package provides support for the following protocols: 3270, 3770/RJE, LU6.2/APPC, LU0, and SDLC. $1,495.
Network Software Associates Inc., 22982 Mill Creek, Laguna Hills, CA 92653; 714/768-4013

CIRCLE 305 ON READER SERVICE CARD

A line of high-performance 386-based LAN servers in a tower configuration has been introduced by **Univation Inc.** All models of the **LifeServer 386/ST** series use a 20-MHz Intel 386 and offer a choice of 170MB, 310MB, or 600MB hard-disk drives. All of the servers are compatible with the IBM PC/AT and are shipped with Univation's



Univation's LifeServer 386/ST LAN server

Advanced LifeNet/386 fault-tolerant network operating system, featuring the advanced database engine architecture and the ability to run in protected mode and take full advantage of the 386 code. The systems come standard with 2MB of RAM (expandable to 16MB), two 5.25-inch diskette drives (choice of 360KB or 1.2MB), a 60MB streaming tape drive, and a monochrome monitor. 170MB, $18,170; 310MB, $20,690; 600MB, $27,540.
Univation Inc., 638 Gibraltar Court, Milpitas, CA 95035; 800/221-5842; 408/263-1200

CIRCLE 308 ON READER SERVICE CARD

IBM Corporation has released **IBM PC LAN 1.3**, a licensed program that provides resource sharing of disk and print devices for interconnected IBM PC and PS/2 models over IBM Token-Ring or PC Networks. Enhanced functions include user login with encrypted passwords, LAN resource administration, and an application-selector menu providing access to multiple servers, messaging, and on-line reference materials. When running in requestor mode, IBM PC LAN 1.3 is supported by the OS/2 LAN Server 1.0. It is available in 3.5-inch or 5.25-inch media. One-time license fee, $225; upgrade until April 28, 1989, $90.
IBM Corporation, 900 King Street, Rye Brook, NY 10573; 800/426-2468; 800/447-4700 for nearest dealer

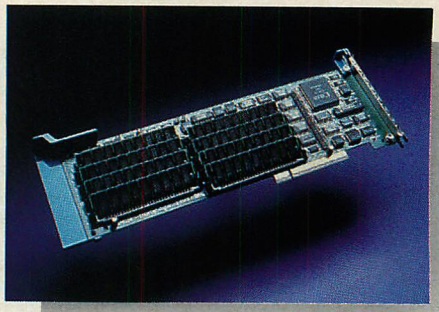
CIRCLE 304 ON READER SERVICE CARD

PC communications and micro-to-mainframe linking software from **Relay Communications Inc.** has been enhanced. **RELAY Gold 3.0** now includes Adaptive Computer Technologies' compression algorithm, CommPressor, for faster transfers and the ability to conduct as many as 15 simultaneous communications sessions. Terminal emulations added to version 3.0 include IBM 3101 character and block modes; VT-220; VT-240; 3278 models 2, 3, 4, 5; and 3279 Models 2 and 3.

Script-language enhancements allow users to download data invisibly and directly import them into PC applications without leaving the application. The product's support for the PS/2 Dual Async Adapter/A allows users to



Alarmcard security system



RampagePlus/MC board from AST Research

take advantage of all eight communications ports on IBM PS/2 computers. Other features include the ability to communicate at speeds as high as 38,400 bps, support for IBM's 101- and 102-key keyboards, and the ability to completely reprogram the keyboard. Users can run RELAY Gold in resident mode with as little as 160KB of memory. $295; upgrade, $75.
Relay Communications Inc., 41 Kenosia Avenue, Danbury, CT 06810; 800/847-3529; 203/798-3800
CIRCLE 309 ON READER SERVICE CARD

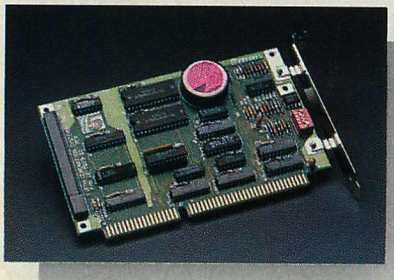
PERIPHERALS

A method of discouraging PC theft is offered by **Alarmcard**. Its half-height add-in board, also named **Alarmcard**, has built-in motion sensors that sound a piercing battery-powered alarm when an unauthorized movement occurs and the power to the computer is off. A user-controlled password stored in battery-protected hardware guards against nonuser access or alarm tampering. Software provided allows complete control of the device through menu options. The product also includes diagnostics, an on-screen battery check, an alarm test, and the ability to control PC movement and data access on a centralized basis. Alarmcard is designed for use with the IBM PC, PC/XT, PC/AT, or compatibles, as well as the PS/2 Models 25 and 30. $119.95.
Alarmcard, 14700 N.E. 8th Street, Suite 205, Bellevue, WA 98007; 206/747-0824
CIRCLE 313 ON READER SERVICE CARD

AST Research Inc. offers two expanded-memory/multifunction boards featuring full EMS 4.0 hardware support, including 32 sets of alternate mapping registers and direct memory access (DMA) paging. **Rampage Plus/286** operates in the IBM PC/AT and compatibles with bus speeds as fast as 12.5 MHz; **RampagePlus/MC** is for use in IBM PS/2 Models 50 and 60.

Both boards offer from 512KB to 8MB of memory on one board. The memory is user-upgradeable in 512KB increments (using 256KB SIMMs) or in 2MB increments (using 1MB SIMMs). Both boards are fully compatible with protected-mode software such as Microsoft OS/2. Extended memory also can be used to create RAM disks and print buffers. Both boards offer optional piggyback I/O modules. Price of both boards: 0KB versions, $595; 512KB versions, $895. I/O board: with two serial ports, $295; with one serial port and one parallel port, $245.
AST Research Inc., 2121 Alton Avenue, Irvine, CA 92714; 714/863-1333
CIRCLE 312 ON READER SERVICE CARD

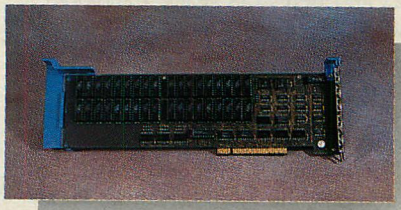
An automatic data backup and security system is offered by **Fifth Generation Systems Inc.** Consisting of an add-in board and software that installs in a PC, **Counterpart** can use a second hard-disk drive to make a mirror-image



Fifth Generation System's Counterpart

backup of all data that have been written on the first drive. In the continuous backup mode, Counterpart automatically and transparently records data on the second drive; upon failure of the first disk, it switches to the second one. Periodic or immediate backups also can be selected. Password security ensures control over user access to diskette and hard-disk drives, data encryption, and user-changed passwords. Price is not yet available.
Fifth Generation Systems Inc., 11200 Industriplex Blvd., Baton Rouge, LA 70809-4112; 800/225-2775; 504/291-7221
CIRCLE 315 ON READER SERVICE CARD

A 4MB extended-memory board for IBM PS/2 Models 50, 60, 70, and 80 is available from **Computer Elektronik Infosys of America Inc.** (CEI). The **MicroFour** board supports OS/2,



MicroFour extended memory board from CEI

Novell, XENIX, and DOS. It uses 1MB DRAM DIP memory chips, which are readily available and cost less than SIMMs. MicroFour can exceed the PS/2's 2MB limit for expansion boards, using a technique that updates the CMOS memory of the PS/2 computer; stored configuration data are changed so that all memory is counted and made accessible when the computer is rebooted, including memory provided by other manufacturers' expansion boards. MicroFour comes with an expanded memory (EMS 3.2) software driver that permits some programs to exceed the 640KB limit of DOS. $399.
Computer Elektronik Infosys of America Inc., 512-A Herndon Parkway, Herndon, VA 22070; 800/322-3464; 703/435-3800
CIRCLE 310 ON READER SERVICE CARD

National Design Inc. is shipping its **Genesis 1024** and **Genesis 1280** intelligent, high-resolution graphics con-

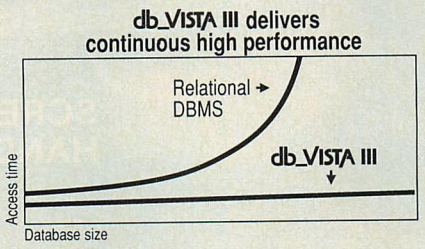
C Programmers

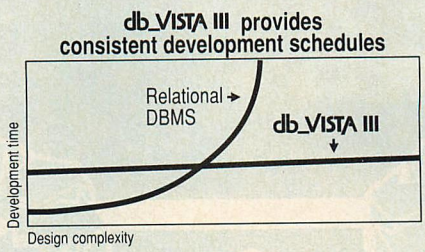
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db_VISTA III™ Delivers High Performance With No Hidden Costs.

For database applications development, you want a system with performance, portability, and full functionality at a competitive price. But there's more to it than that. The long term costs associated with extended development schedules, frequent maintenance, excessive royalties, or the inability to handle complex data relationships are often overlooked. These hidden costs can be quite a shock after you have made a commitment and are midway through application development, or worse yet, in production.

With db_VISTA III from Raima, there are no surprises. It provides powerful database capability with tremendous overall cost savings. The heart of the system is db_VISTA, a high performance DBMS that uses B-tree indexing and the network database model file structure to minimize overhead and provide fast data access. Our SQL-based db_QUERY provides a relational view of the network structure, without sacrificing performance. And db_REVISE lets you easily redesign your database. The entire db_VISTA III system is fault tolerant and complete source code is available.





db_VISTA: High Performance DBMS
Multi-user
Fast data access: B-tree indexing, network database model, virtual memory disk caching
Multiple Database Access
Referential integrity
Automatic recovery
Record and file locking
Database consistency check
Easy-to-use interactive access programs
Data Definition Language patterned after C

db_QUERY: SQL-based Query
Relational interface to db_VISTA databases
Yields extraordinary performance
Build ad hoc queries & reports

db_REVISE: Database Restructure Program
Redesign your database
Converts existing data to revised design
Upgrade remote end user locations easily

Add WKS Library for Lotus 1-2-3
Fast C interface to Lotus, dBASE and others

Operating Systems: VMS, ULTRIX, UNIX System V, BSD 4.2, SunOS, QNX, XENIX, OS/2, MSDOS, Macintosh, MS Windows

C Compilers: VAX, UNIX, XENIX, SunOS, Microsoft, Lattice, TurboC, LightspeedC, MPW

LANs: NFS, 3Com, NetWare, LifeNet, Banyan, and any other MS-DOS NetBIOS-compatible LAN. AppleShare and network-independent versions also.

Thousands of C programmers in over 50 countries worldwide have chosen Raima's db_VISTA III. Here are the reasons why:

- Fast data access
- Minimal data redundancy
- C source code available
- Automatic recovery
- Multi-user support
- Portable to VMS, UNIX, OS/2, MS-DOS and Macintosh
- SQL-based relational query
- No royalties
- Professional services
- Superior support

Maybe it's time that you checked out db_VISTA III. Consider *all* the costs. It could be the easiest choice you ever made.

CALL:

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Ask about the many other products and services Raima Corporation offers, including consulting, application development, and training.

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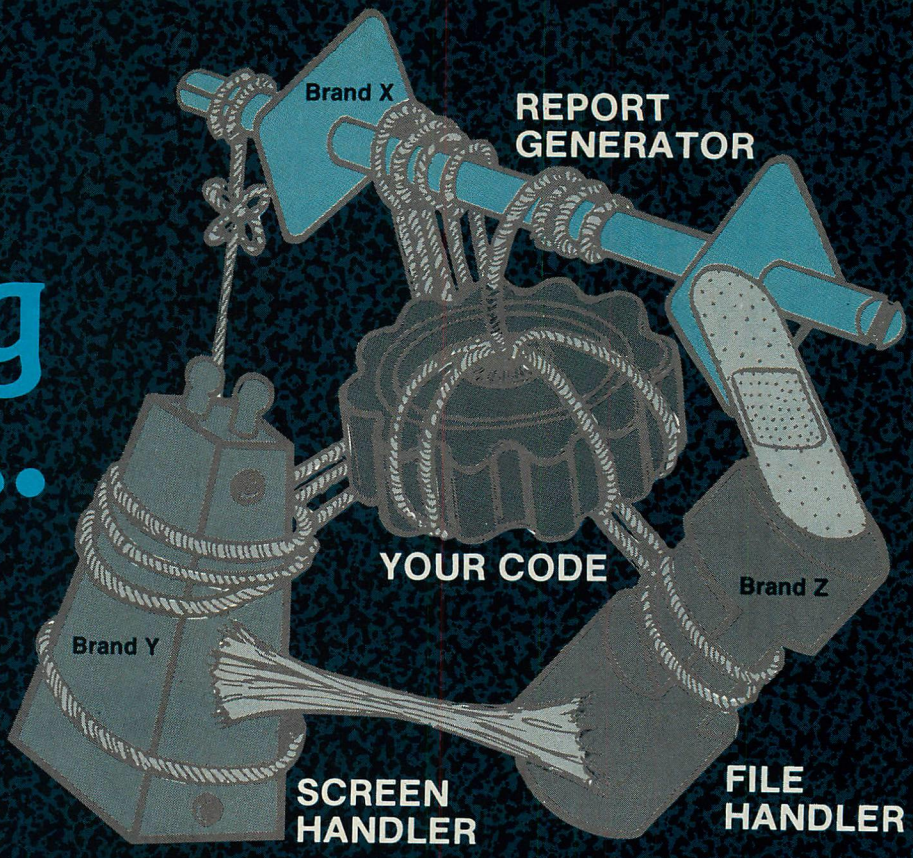
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PT 108

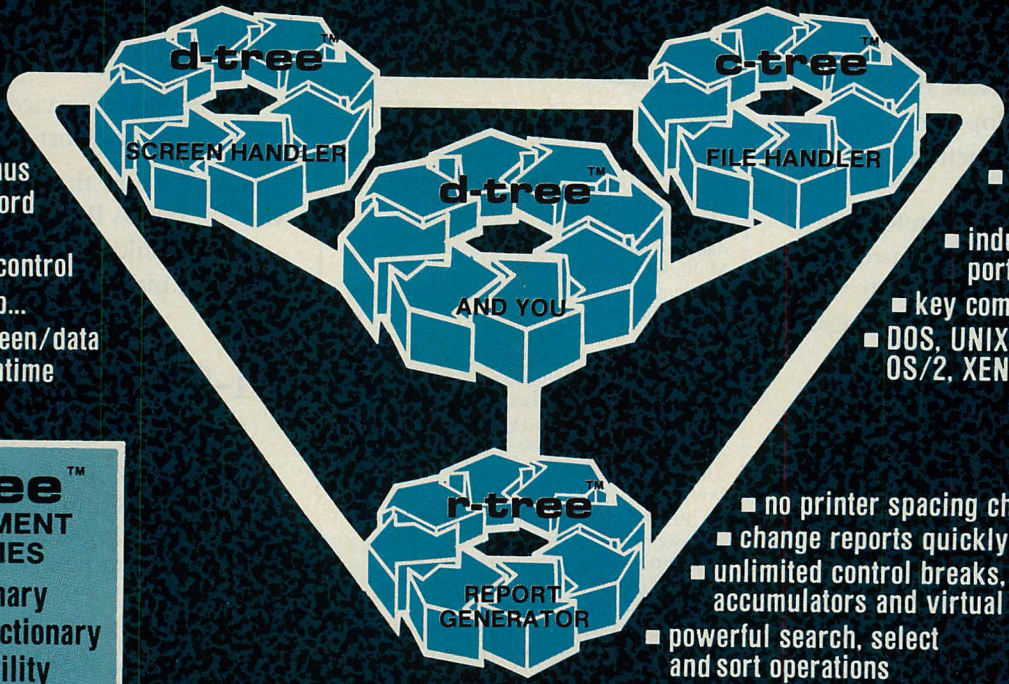
Raima Corporation 3245 146th Place S.E., Bellevue, WA 98007 USA **(206)828-4636** Telex: 6503018237 MCI UW FAX: (206)828-3131 In **Texas** call: (214)231-3131
International: **U.K.**: (0992)500919 **Germany**: 07127/5244 **Switzerland**: (01)725 04 10 **France**: (1)47 72 77 77 **Benelux**: (02159)46 814 **Sweden**: (013)124780
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- pop-up help... change screen/data files at runtime

- fixed and variable length data fields
- unparalleled speed of B+ trees
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- no printer spacing charts
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- unlimited control breaks, accumulators and virtual fields
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d-tree™ MANAGEMENT FACILITIES

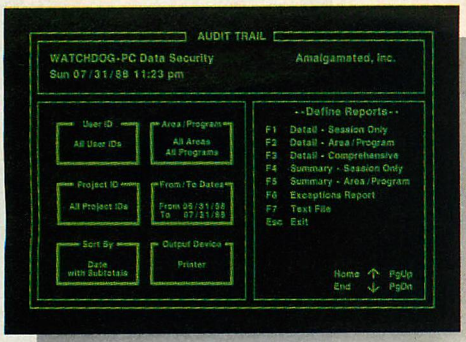
- data dictionary
- program dictionary
- data portability
- change file structure easily
- application generation tools
- c-tree/r-tree — with ease

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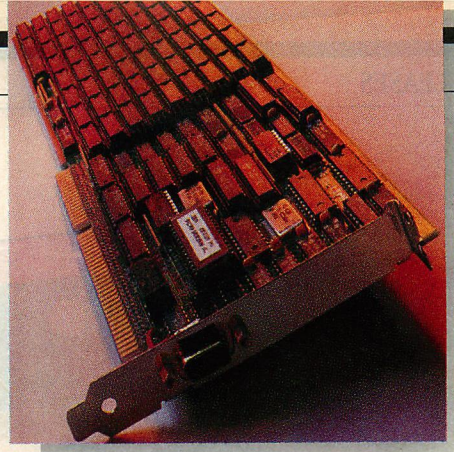
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CIRCLE NO. 119 ON READER SERVICE CARD

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Watchdog audit-trail menu screen from Fischer International Systems



Newer Technology's LIMfile memory-expansion board

trollers that are now bundled with **MetaWINDOW/PREMIUM**, an implementation of **Metagraphics Software Corporation**'s MetaWINDOW graphics toolkit. Using MetaWINDOW/PREMIUM in conjunction with the Genesis controllers allows MetaWINDOW users to execute graphics code 10 to 40 times faster without having to write special drivers for Texas Instruments' 34010. Users can save memory by moving the MetaWINDOW graphics subroutines and video images from the PC to the Genesis controller. Genesis 1024, $1,700 to $2,995; Genesis 1280, $2,995 to $3,995; MetaWINDOW/PREMIUM, $95.
National Design Inc., 9171 Capital of Texas Highway North, Houston Building, Suite 230, Austin, TX 78759; 512/343-5055
CIRCLE 316 ON READER SERVICE CARD
Metagraphics Software Corporation, 269 Mount Hermon Road, P.O. Box 66779, Scotts Valley, CA 95066; 800/332-1550; 408/438-1550
CIRCLE 317 ON READER SERVICE CARD

An enhanced version of **Fischer International Systems Corporation**'s data-security software for the IBM PC and PS/2 models and compatibles is available. **Watchdog 5.0** integrates ID and password access control, automatic data encryption transparent to users, multiple file-access and user-permission levels, and audit trails for logging all system and user activity. Version 5.0 features an execute-permission option that allows users to execute programs but prevents them from copying, erasing, or altering them. It also includes the data encryption standard (DES) algorithm, a menu-builder option, a utility profile that allows the system administrator to password-protect system files, and a defense against potential misuse of hard-disk utilities. $295.

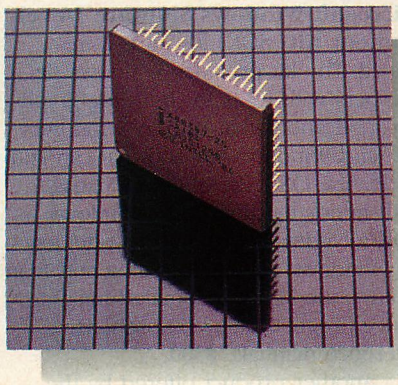
Watchdog Armor, a half-size card that works with the Watchdog software, controls system booting, requiring the PC to boot from the hard disk only. It also features a secure clock that is protected from modification and a hardware form of the DES. $129.
Fischer International Systems Corporation, 4073 Mercantile Avenue, Naples, FL 33942; 800/237-4510; 813/643-1500
CIRCLE 314 ON READER SERVICE CARD

A 16-bit memory-expansion board that offers the dual-performance benefits of multiple register EMS 4.0 support and high-speed, nonvolatile RAM disk has been announced by **Newer Technology**. Full multiple hardware register support allows the **LIMfile** board to run more than twice as fast as single-register-supported EMS 4.0 memory boards. LIMfile is available in volatile and nonvolatile versions. The nonvolatile version includes onboard memory refresh, with connection to an optional external power supply.

LIMfile can deliver as much as 16MB (main board plus optional piggyback board) in a single slot. The board is compatible with AT-bus systems operating at bus speeds from 6 to 24 MHz. The board can be purchased in a ready-to-use soldered version or in a user-upgradeable socketed configuration. 0KB version, $790; 2MB version, $2,160; piggyback board, $300; 2MB upgrade kit, $1,330; external power supply, $260.
Newer Technology, 1117 S. Rock Road, Suite 4, Wichita, KS 67207; 800/678-3726; 316/685-4904
CIRCLE 311 ON READER SERVICE CARD

TECHNOLOGY

A math coprocessor designed especially for 25-MHz systems based on the Intel 80386 has been announced by **Intel Corporation**'s Personal Computer Enhancement Operation (PCEO). The 25-MHz, 32-bit **80387-25 Math Coprocessor** processes numeric computations as much as 50 times faster than 25-MHz systems without a math coprocessor, and it extends the 386 instruction set to include trigonometric, logarithmic, exponential, and arithmetic instructions. The product installs easily into a socket on the system board of all 25-MHz 386 systems. $1,395.



Intel PCEO's 80387-25 math coprocessor

Intel Corporation PCEO, Mail Stop C03-07, 5200 N.E. Elam Young Parkway, Hillsboro, OR 97124-6497; 800/538-3373
CIRCLE 301 ON READER SERVICE CARD

SOFTWARE DEVELOPMENT

Microsoft Corporation has unveiled **Version 2.1** of **Windows/286**. In the IBM PC/AT and compatibles, this version provides as much as 50KB extra addressable memory when more than 1MB of extended memory is available; for PS/2 models, the same extra memory is achieved with 1MB. The enhanced installation program automatically detects the user's hardware configuration, such as the display, graphics card, and extended or expanded memory configuration. Features include easier installation, support for 128 printers and plotters, updated AST Rampage support to full EMS 4.0 specifications,



The Software Bottling Company's SoftCode program generator



Norton Commander 2.0 from Peter Norton Computing

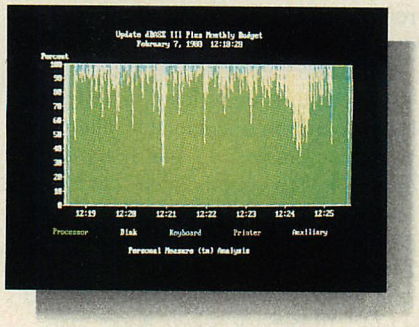
updated Intel Above Board support to full EMM specifications, and support for IBM 8514/A, Wyse 700, and Micro-Display System Genius displays. $99.

An enhanced version of the **Microsoft Windows Software Development Kit** (SDK) also was introduced. The kit provides Windows developers with tools for building graphics applications that run on Windows/286 and Windows/386 and that can run under the OS/2 Presentation Manager with minor modifications. Windows SDK includes the Microsoft CodeView for Windows debugger, dialog and icon editors, the MAKE automated maintenance program, and comprehensive reference manuals. $500.

Another product offered by the company is **Microsoft COBOL 3.0,** which supports the memory requirements of mainframe applications, generates code that runs 10 times faster than the previous version, and is compatible with mainframe, minicomputer, and microcomputer COBOL dialects, including IBM's mainframe COBOL compilers. Microsoft COBOL 3.0, which meets the ANSI standard for COBOL, comes with a complete set of development tools for the DOS and OS/2 applications developer, including Micro Focus's Animator debugger and the Microsoft Editor. $900; upgrade, $300.
Microsoft Corporation, 16011 N.E. 36th Way, Box 97017, Redmond, WA 98073-9717; 800/426-9400; 206/882-8080
CIRCLE 319 ON READER SERVICE CARD

An enhanced release of **Micro Focus Inc.**'s compiler for OS/2 and DOS programming is available. **Micro Focus COBOL/2 1.1** is equivalent to Microsoft Corporation's COBOL version 3.0; Microsoft licenses the COBOL compiler and Animator debugging tool in Microsoft COBOL 3.0 from Micro Focus (the two companies have signed a strategic alliance agreement to develop and market COBOL application tools). COBOL/2 1.1 includes the COBOL/2 native code-generating compiler and Animator. Enhanced features include compile-time and runtime support for certain features of Microsoft COBOL 2.2; transparent handling of Microsoft file status values; file formats; and support for SELECT and OPEN LOCKING, .COB file-name extension, and Microsoft extension routines. $900.
Micro Focus Inc., 2465 E. Bayshore Road, Palo Alto, CA 94303; 800/872-6265; 415/856-4161
CIRCLE 320 ON READER SERVICE CARD

A software program that analyzes the performance of hardware and software running under DOS has been announced by **Spirit of Performance Inc.** For any set of measurement data, **Personal Measure** allows the user to



Graph report generated by Personal Measure

analyze the entire data set or data within a time interval or a single program. Personal Measure gives clear, concise reports in graph and table form that show which resources were used during the selected measurement interval and how much time the PC spent computing, accessing disks, waiting for keystrokes, printing, and using a communications line. 5.25-inch diskette, $69.95; 3.5-inch diskette, $74.95.
Spirit of Performance Inc., 73 Westcott Road, Harvard MA 01451; 508/456-3889
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The generation of any type of code in any program language is possible with **SoftCode**, a program generator from **The Software Bottling Company**. SoftCode reads program templates to control what it generates, and it provides a complete, fully documented Program Template Language. The templates can be changed to personalize the code generated. SoftCode template sets are available for BASIC, Pascal, C, and dBASE; others are under development. SoftCode also includes a screen editor. With one template set, $195; additional template sets, $49 each.
The Software Bottling Company, 6600 Long Island Expressway, Maspeth, NY 11378; 800/872-8787; 718/458-3700
CIRCLE 322 ON READER SERVICE CARD

An upgrade of the DOS enhancement shell and file manager from **Peter Norton Computing** is now available. **Norton Commander 2.0** features built-in Lotus 1-2-3 and Symphony, and Ashton-Tate dBASE file viewers for browsing of spreadsheet and dBASE files. Also included is an asynchronous File Find feature that lets users view and change found files in a full-screen, scrollable window; 43-line EGA and 50-line VGA displays; and directory-tree panels that can display a hierarchical directory tree in one panel and a file listing in the other. $89.
Peter Norton Computing, 100 Wilshire Blvd., Suite 900, Santa Monica, CA 90401; 213/319-2000
CIRCLE 327 ON READER SERVICE CARD

A completely integrated Ada programming support environment, **IntegrAda** has been introduced by **Aetech Inc.** This environment includes all of the tools required to design, code, compile, debug, and document code in accordance with military specifications. Key features of IntegrAda include an on-line library management system; math, text, and console packages; mul-

PolyDoc:™ The Source Code Documentation Compiler.™

Automatically Generates & Maintains Documentation.

Documentation: Critical But Often Overlooked

Documenting source code is an important but often overlooked part of a software development project. It is common for members of the development team to tolerate a total lack of documentation only to suddenly "discover" how important it is when the project is completed or when a programmer joins or leaves the team. The reason most teams don't document their code is that until now there has been no easy and convenient way to compile, access and share the documentation. Now, with PolyDoc, personal computer software development teams and entire organizations have an easy and practical way to document code.

Compile Documentation

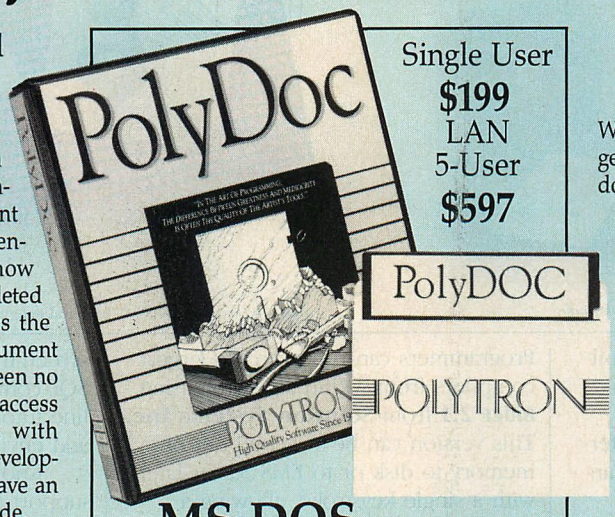
PolyDoc can best be described as a "Documentation Compiler" because it assembles documentation directly from your source code. PolyDoc works by scanning source code and extracting explanations, or comments and code segments which the programmer has embedded in the source file. These components are then automatically compiled into a Project Documentation Library (PDL) and can be viewed on-line or printed at any time by members of the project team.

Visually Navigate The Library

A PDL is divided into sections that are visually cross-indexed so that information can be accessed via more than one "path" through the PDL. The Project Leader or Manager has complete control over how these sections and subsections are automatically organized.

A Resource For The Workgroup

To scan a document and compile the PDL, PolyDoc operates as a stand-alone application. Then, members of the team can have instant, read-only access to the PDL. They can visually navigate the hierarchy of the PDL to view or print selected sections, or even the entire PDL. The ViewPrint program (which can be memory-resident or stand-alone) allows members of the workgroup — Programmers, Project Leaders, Managers, Quality Assurance Personnel and Technical Writers — to instantly access the PDL on a Local Area Network. The Network version of PolyDoc allows members of the workgroup to access the same PDL simultaneously. Since PolyDoc will not modify source files, maintaining the integrity and security of source files is not a problem.



MS-DOS

What Is Source Code Documentation?

Source Code Documentation is any text that explains or defines how software functions, how it is made, or what it is intended to do. Typically, source code documentation includes a synopsis of what a section of code does and what effects it has. A PolyDoc PDL can also contain system and functions specifications, subsystems, module and function summaries, progress reports, bug reports, even extracts from memos. In short, a PDL can include any document that needs to be consulted on a regular basis and kept as part of a project's permanent record.

PolyDoc Benefits:

- No Need For Separate Documentation Files
- Readily Accepted By Programmers & Managers
- Offers Companies A Standard Documentation Method
- New Programmers Can Get Up-To-Speed On A Project Quickly
- Team Can Share Documentation On Local Area Network
- Increases Productivity During Specification, Coding, Debugging & Maintenance Phases

PolyDoc requires MS-DOS Version 2.0 or later and runs on an IBM PC, XT, AT or compatible. DolyDoc uses 90K of RAM in memory-resident or stand-alone mode. A hard disk is recommended.

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Single User Version $199. A Five-User Network Version is $597. Call for prices on larger networks.

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1700 NW 167th Place, Beaverton, OR 97006
(503) 645-1150 — FAX: (503) 645-4576

Quick Answers To Important Questions

With a PDL in place for your project anyone can get immediate answers to questions like: "What does this function do?", "Which source file contains this module?", "Who wrote this function?", "What other existing functions are related to it or do similar things?", "Is this a reported bug and who is fixing it?", "What does the specification document say about this particular feature?"

Use on Existing Projects

Because you can begin using PolyDoc on projects currently under development, team communication and programmer productivity will be improved immedately. You can also use PolyDoc on any project because PolyDoc will scan and compile a PDL for source code written in ANY language.

On-Line Help For Immediate Productivity

PolyDoc is easy to learn, featuring a pull-down menu interface and instant context-sensitive help. Once you become proficient with PolyDoc you can bypass menus with accelerator keys.

Comprehensive Manual With Tutorial

The PolyDoc User's Manual contains practical examples of organizing a project. A comprehensive tutorial gives you a step-by-step description of how a project is documented using PolyDoc. The tutorial follows a software project from initial design specifications through the maintenance phase of the software life cycle.

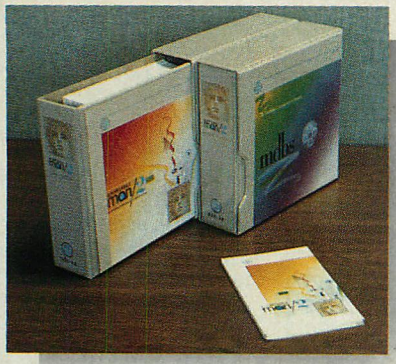
Use PolyDoc With PolyMake & PVCS

If you are already using PolyMake, or any other Make utility, to automate the building of a project's software, why not use it to automate the compiling of source code documentation as well. PolyMake can automatically invoke PolyDoc so any changed module will be scanned. This means your PDL will always reflect the current state of the project. To help provide an audit trail of the project, or if you wish to keep prior versions of your PDL, the POLYTRON Version Control System (PVCS) can store the differences between PDLs and then quickly reconstruct any prior version.

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KnowledgeMan/2 from mdbs



DOS 4.0 (left) and DOS 4.0 Technical Reference *from IBM Corporation*

tiple-file code retrieval; full-color, full-featured editing; selectable function keys; Ada subprogram and package generation; Ada type generation; interactive cursor error correction, and an interface to Ada Design Language (ADADL). $495.
Aetech Inc., 380 Stevens Avenue, Suite 314, Solana Beach, CA 92075; 619/755-1277

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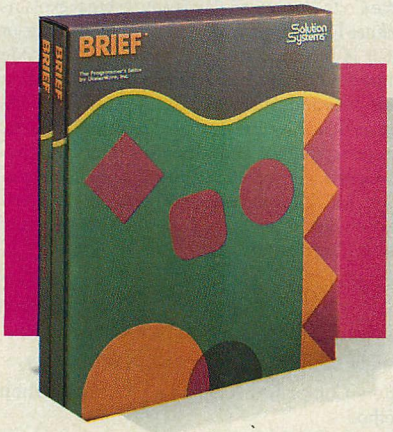
An easier-to-use version of **IBM Corporation**'s disk operating system, **DOS 4.0** offers a menu-driven user interface and support for large files and expanded memory. A DOS Shell that resembles the OS/2 Presentation Manager is an alternative to the DOS prompt. Menu selections are used to start up and use applications, access information and data in the file systems, obtain hard-copy output, and get help information. DOS 4.0's support of large hard disks allows storage of files greater than 32MB, and expanded-memory support allows the user to address memory above 640KB and to run programs written to EMS 4.0.

Other features include enhanced video/graphics support for printing of graphics screens, additional video-mode settings, and display of more than 25 lines of text. Introductory documentation is included; the ***DOS 4.0 Technical Reference*** is optional. With two 720KB 3.5-inch diskettes, $150; with five 360KB 5.25-inch diskettes, $150; upgrade, $95. *DOS 4.0 Technical Reference,* $105.

IBM also has released **DOS 4.0 and Windows Kit for PS/2**, a starter set of applications based on Microsoft Windows/286, that includes word processing, spell checking, equation editing, and graphing. $314.
IBM Corporation, 900 King Street, Rye Brook, NY 10573; 800/426-2468; 800/447-4700 for nearest dealer

CIRCLE 318 ON READER SERVICE CARD

Programmers can run even the largest compilers from within an editor using **BRIEF 2.1** from **Solution Systems Inc.** This version can be swapped out of memory to disk or to EMS 3.2 or later with a single keystroke, allowing a choice of compilers. After compiling, the cursor positions at each syntax error. BRIEF 2.1 includes a warnings-



BRIEF 2.1 from Solution Systems

only feature that points out potential trouble spots; faster searching; a pop-up menu for listing and selecting files; and bookmarks that allow tagging of as many as 10 different spots within files. $195; upgrades from version 2.0 and later, $35; from earlier versions, $60.
Solution Systems Inc., 541 Main Street, Suite 410, S. Weymouth, MA 02190; 800/821-2492; 617/337-6963

CIRCLE 321 ON READER SERVICE CARD

DATABASE MANAGEMENT

Version 2.5 of **KnowledgeMan/2,** a relational database management system with fourth-generation decision support and application-development capabilities, is available from **Micro Data Base Systems Inc.** (mdbs). The product includes enhanced debugging tools and screen-management capabilities, an SQL-compliant data dictionary, an online tutorial, and enhanced functions and environment controls.

KnowledgeMan/2 includes decision-support capabilities: a report generator, business graphics, text processor, forms painter, natural language interface, and remote communications. $695. Upgrades for registered users: single-user version, $150; LAN version, $200.
Micro Data Base Systems Inc., P.O. Box 248, Lafayette, IN 47902-02487; 800/344-5832; 317/463-2581

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An enhanced version of **Fox Software Inc.**'s dBASE-compatible database management system has been released. **FoxBASE+ 2.1** includes a completely integrated template system, including FoxView, FoxGen, and FoxCode modules for preparing data-entry and editing screens and compiling instructions into fast, compact code.

An enhanced virtual-memory management system writes FoxBASE+ 2.1 to disk, automatically creates a view of the operating environment, and closes any open databases. The exact operating status present before calling one of the template programs is restored automatically when the template program concludes, allowing large memory-intensive programs to run from within FoxBASE+ while ensuring data integrity. FoxBASE+ 2.1, $395; FoxBASE+/386 2.1, $595; FoxBASE+/LAN 2.1, $595. Unlimited runtime versions: single-user and 386 versions, $500; LAN multiuser version, $700.
Fox Software Inc. 118 W. South Boundary, Perrysburg, OH 43551; 419/874-0162

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The material that appears in Tech Releases is based on vendor-supplied information. These products have not been reviewed by the PC Tech Journal *editorial staff.*

ADVANCED | REVELATION

This wasn't supposed to happen until the year 2000.



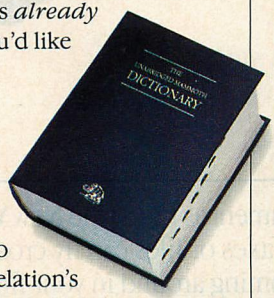
A thrilling leap forward for database management

Advanced Revelation™ brings remarkably powerful tools, infinite flexibility and vastly increased productivity to the PC environment.

Making it the developers' choice when handling sophisticated network applications such as sales, personnel and asset management.

Yet it's simple enough for non-technical users to build applications after one day's training.

As you read on you'll see: with Advanced Revelation, database management is *already* everything you'd like it to be.



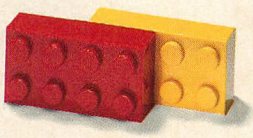
Data Dictionary eliminates source code

The gateway to Advanced Revelation's power is our central, active data dictionary. It contains everything you need to define the attributes of each field and bring life to your applications.

No other system has anything like it. When you change, add or delete fields, the dictionary remembers and records it for you. Without programming or coding.

Environmental Bonding™ improves all your existing capabilities

Environmental Bonding brings Advanced Revelation's powerful features to your existing applications.



Making your investment in systems—PC based, Mini or Mainframe—provide even greater returns.

Because for the first time, this breakthrough technology lets you use your existing information—read and write from other systems—with Advanced Revelation's Application Tools.

Seamlessly. Which means no disruptive data conversions, duplicate data or cumbersome and time-consuming import/export requirements.

Variable Length Fields extend your flexibility

With other DBMS's, once you define the number of characters in a field, it's set in stone.

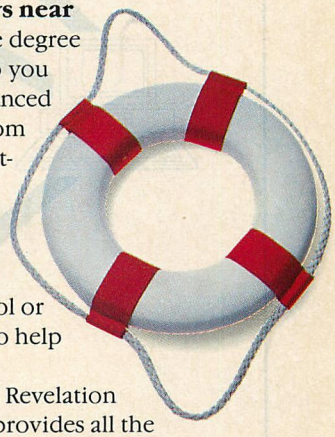
Not so with Advanced Revelation's variable length fields. Where you can enter virtually any number of characters into a field. Making it especially nice for text-oriented information.

What's more, variable length fields are only as long as the information they hold. Using an average of 40% less disk space than any fixed length system.



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You can set the degree of on-line help you need with Advanced Revelation. From simple, context-sensitive help that automatically appears each time you enter a new tool or program. To no help whatsoever.



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It's all part of the forward thinking our customers have come to rely on.

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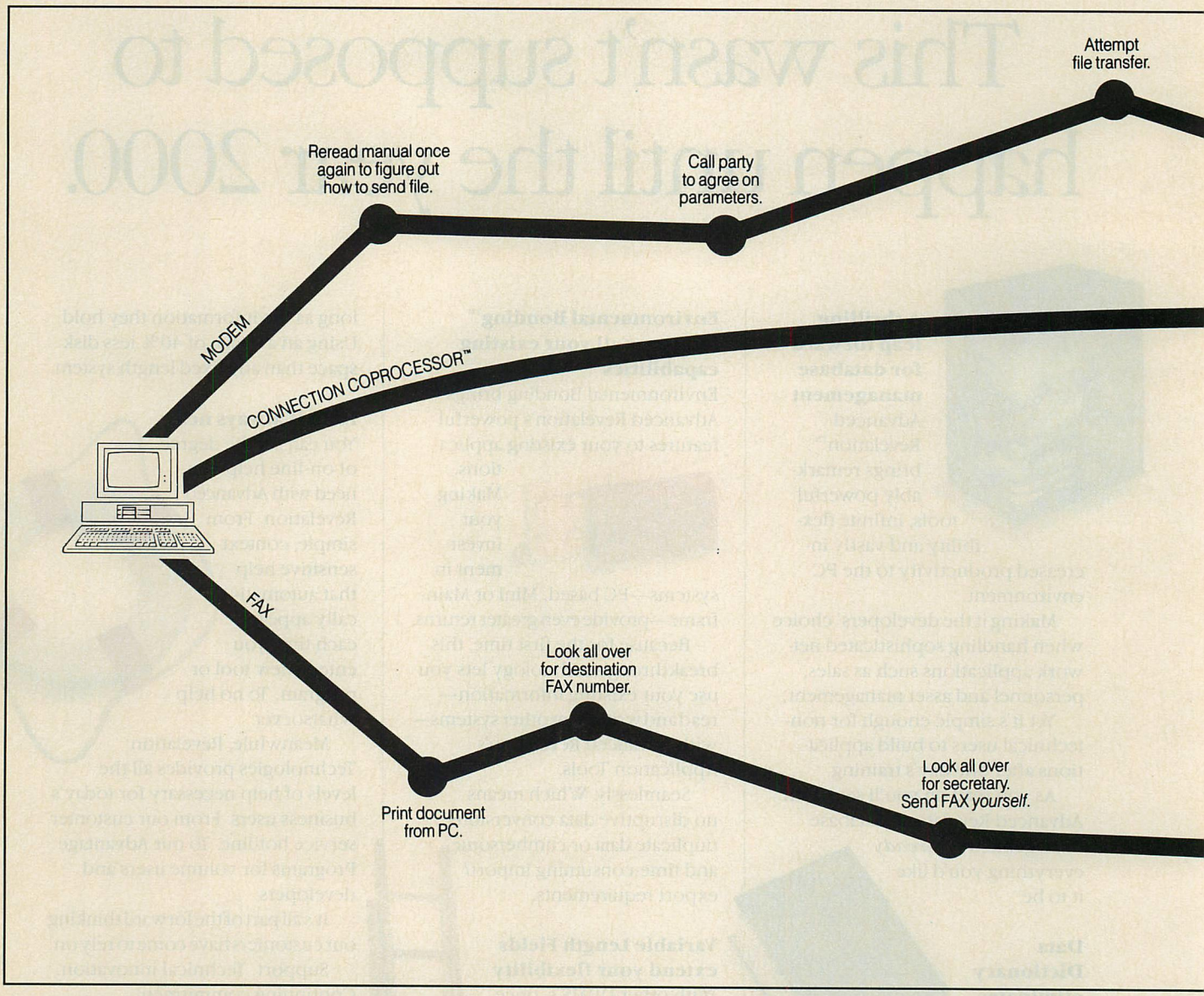
RevelationTechnologies

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Two Park Avenue, New York, NY 10016 (212) 689-1000 3633 136th Place SE, Bellevue, WA 98006 (206) 643-9898 Note: Advanced Revelation is compatible with the IBM PC-AT, IBM PS/2 and other 100% compatibles; it supports the DOS and OS/2 operating environments and all major PC networks. Advanced Revelation and Environmental Bonding are trademarks of Revelation Technologies Inc.

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Announcing the first non-stop communications route between businesses anywhere in the world.

Intel's Connection CoProcessor.™

It's a whole new way to send and receive programs, files, text, graphics and electronic messages. Not just between PCs, but with fax machines as well.

The Intel Connection is a new communications coprocessing board that frees your PC from the task of communicating.

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Now your faxes or files can fly cross country. And you can still be zooming around in your flight simulator. Or writing that letter to your biggest account. Or recalculating your spreadsheets for tomorrow's meeting. Without interruption or downtime.

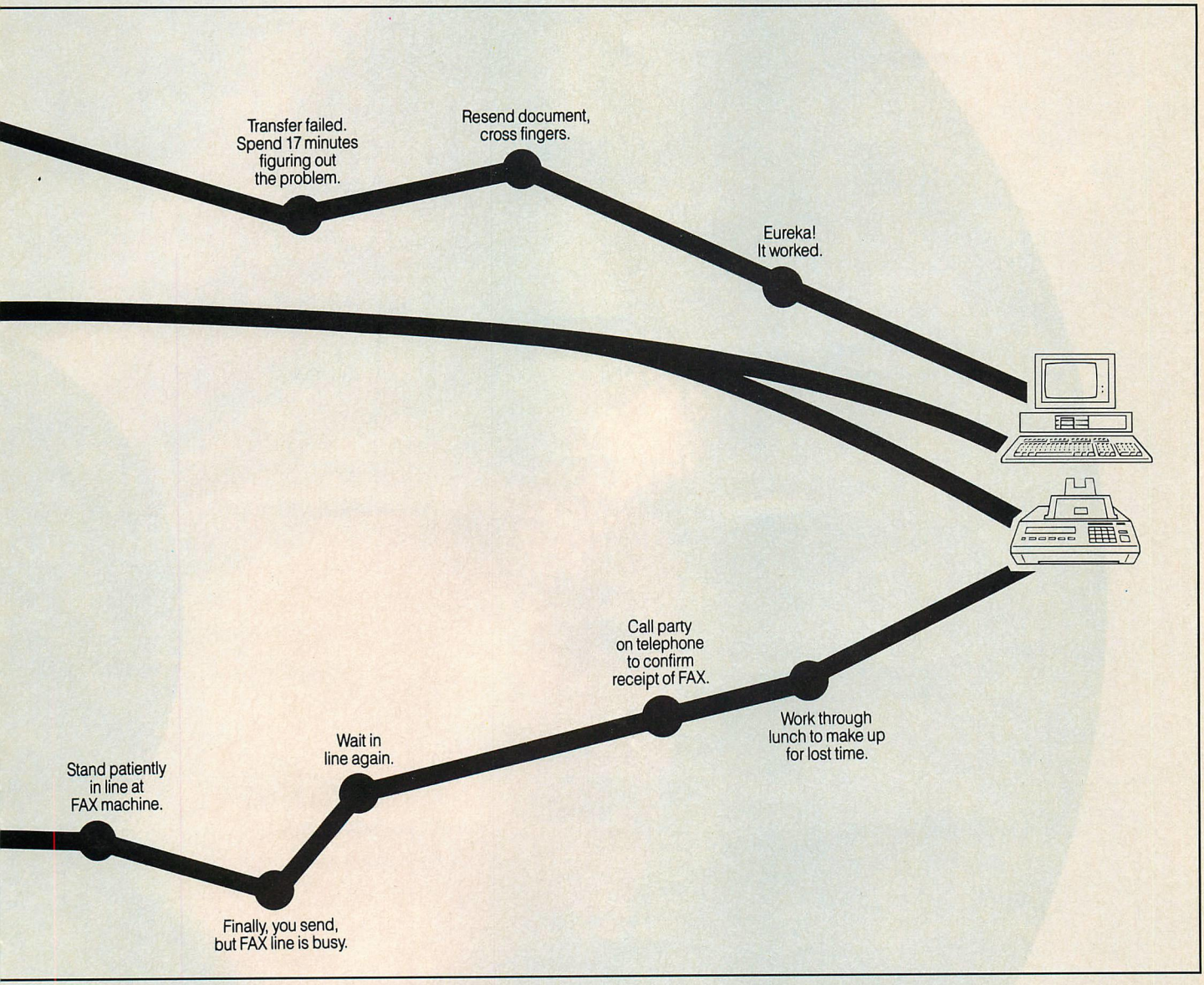


And when you fax, there are no more stopovers at the printer, or cooling your heels in line at the fax machine. Because Connection lets you do everything without leaving your PC.

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non-stop flights.



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CD-ROM Publishing Strategies

Although CD-ROM delivers portable data storage-and-retrieval capacity far greater than any other media for the PC, it creates a new set of challenges for the systems developer.

LINDA W. HELGERSON and FRED P. MEYER

Producing a CD-ROM is a huge undertaking. The process requires a great deal of planning, analysis, and manipulation of data to produce the read-only-memory compact disks that users find eminently easy to use. This is a growing industry, though, and production costs have come down gradually since the technology first came on the scene in 1985. Further, owners of data sets who are contemplating the use of CD-ROMs can choose the tasks they will perform themselves and those they will relinquish to one of the many data-preparation companies around the country.

Adapted from the now well-established CD audio technology, CD-ROM's most attractive feature is its size advantage over conventional storage-and-retrieval media. Each CD-ROM holds about 600MB of data. The same data that require 4,222 yards of shelf space for books (not to mention the obvious headache of finding the information within) require only 1.3 yards for CD-ROMs—with their automated search-and-retrieval methods (see the second article in this suite, "In Search of CD-ROM Data," Linda W. Helgerson and Harvey G. Martens, p. 66).

The most obvious restriction of a CD-ROM is that it is a read-only medium: data are encoded onto a glass master disk at a manufacturing facility and cannot be "replaced" on the disk once it is mastered. Duplicate disks are produced from the master, much like a standard printing operation.

Most CD-ROMs are designed for a specific user group, and all aspects of production are based upon user requirements. Developers considering such a project can answer some basic questions about their data sets and target audience to arrive at a decision. CD-ROM is not the answer for all publishing ventures, but for many projects that require the economic distribution of large, stable quantities of digital data, CD-ROM has no equal.

To determine whether CD-ROM is appropriate for a project, consider the following questions, in order:

1. What is the overriding requirement for the data set: archiving, dissemination, or a combination of the two? If your overriding requirement is data dissemination, then CD-ROM is a strong contender.
2. What kind of information do you wish to archive and distribute: analog or digital data? If you are disseminating digital data—text, audio, graphics, video—then CD-ROM becomes an even stronger contender.
3. How much information do you wish to archive or distribute: kilobytes, megabytes, or terabytes? If you want to disseminate between 100MB and 663MB of digital data, then CD-ROM is probably the most efficient and economical means.
4. What type and how stable is the information that you wish to archive or distribute: is it transaction-oriented, archival, or periodically updated? If you have relatively stable digital data—updated monthly, quarterly, or annually—then CD-ROM really begins to stand apart.
5. What is your budget to archive or distribute this information? If you want to disseminate stable quantities

PHOTOGRAPHY • STUDIO 65 CD-ROM COURTESY OF NEC HOME ELECTRONICS (U.S.A.) INC.

of digital data in the most economic manner, then CD-ROM is probably the only answer.

The answers to these questions can lead to very different choices for archiving, publishing, and distributing information. No one publishing medium is appropriate for all applications, not even one as attractive as CD-ROM.

CD-ROM applications fall into two general categories. In the first are stand-alone, information-retrieval systems, designed not only to distribute the information but to provide a means of accessing it on the CD-ROM. Such a disk contains not only the data, but also the indexing structures that enable efficient access. For the second category, distribution, not retrieval, is a primary goal. Here, the CD-ROM is a distribution medium for data meant for downloading to magnetic media; its contents are primarily data with limited indexing. Each category has different criteria for determining an application's suitability to the CD-ROM medium.

Development of a CD-ROM title involves many interrelated tasks (see figure 1), and all operations must be coordinated. An initial *analysis of requirements* guides all decision-making during development. If the intended audience is, for example, architects and construction engineers, then the type of data, the indexing structure, the search-and-retrieval techniques, even the user interface, will differ from those developed for an audience of professional researchers, high-school students, or financial analysts. Developers working on the design and production process become translators—intermediaries of the requirements—and their work depends upon and stems from the criteria for a specific CD-ROM application.

Potential CD-ROM publishers develop requirements analyses by considering market research or user needs, examining competitive CD-ROMs or other media products, and becoming familiar with distribution channels (which often suggests how to price and position a product). The capabilities of one application may place it in the $10,000-and-up range; such a product has considerably different requirements from one priced less than $200. Requirements analyses are equally important for products aimed at internal and external buying markets.

The data set itself may require some preliminary manipulation. The material should be as clean—that is, up-to-date and free of repetition—as possible to make the best use of disk space. In addition, the data must be in machine-readable format, which could mean rekeying, scanning, or reformatting (if, for example, typesetting codes are embedded in the data). Also, consider who will perform these tasks—they could be done either in-house or contracted to an outside firm.

THE APPROPRIATE FORMAT

Based on the outcome of the requirements analysis, four factors determine whether CD-ROM is an appropriate publishing and distribution format: the potential publisher's goal, the characteristics of the database, the information requirements of the end user, and the hardware requirements of the targeted end-user market. The "right" combination of these reasons will compel a publisher to consider CD-ROM as an alternative or replacement data-distribution medium.

Of all the reasons why a potential CD-ROM might not proceed, the cost of converting data to machine-readable format looms largest.

Although profitability seems a likely impetus in any case, other motivations can be more important: encouraging long-term competitiveness, moving into new markets with enhanced goods and services, increasing the life cycle of a database product.

Even when profit is possible, other reasons may oblige a developer not to pursue CD-ROM as the publishing vehicle. Of all the reasons why a potential CD-ROM might not proceed, the cost of converting data to machine-readable format looms largest. Such costs can exceed those for production hardware/software and manufacturing combined.

Yet, even with the costs of data conversion, producing CD-ROMs is very worthwhile. The per-unit costs are less, sometimes by a substantial margin, than alternative forms of data distribution. This factor favors CD-ROM publishing, especially when it is backed up by other determinants—a large quantity of data, a minimum of perhaps 100 internal user sites or 500 highly probable buyers, a relatively stable and available set of data, database updates that are easily accomplished on a regular basis, and easy access to the data. However, the cleanliness of the data is important in any case.

HAVING DECIDED . . .

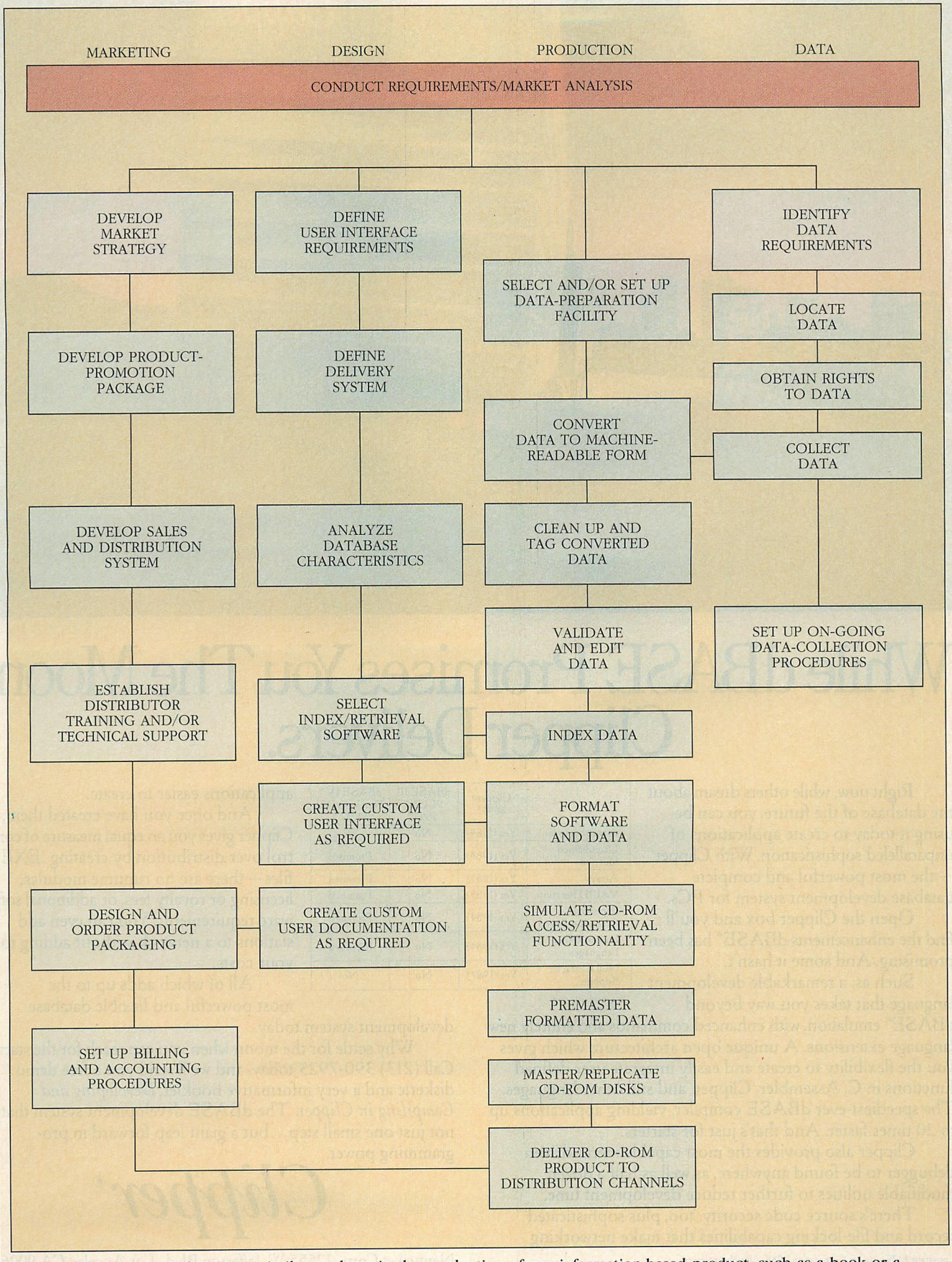
When you have determined that CD-ROM is an appropriate medium for publishing your data, and you have converted the data into machine-readable form, the next step is to structure the data into an image of its final form on the optical disk. Typically, this requires sorting, merging, indexing, and laying out the file and directory structure of the database. The tools for performing these tasks are called *authoring* and *premastering* systems, and they are commercially available for a variety of environments. (The sidebar "CD-ROM Authoring/Premastering Systems" on page 57 lists several companies that offer CD-ROM preparation environments for the PC.)

With rare exception, today's CD-ROM applications are destined for microcomputers, so it would seem reasonable to develop these applications on the target machine. But this approach presents one inherent problem. In standard configurations, microcomputers simply do not have the resources or the operating-system software to support the large data-set manipulations that are required in a CD-ROM production environment. For example, most versions of DOS do not permit a file size greater than 32MB.

The file structures in microcomputer operating systems were designed to provide random access to files of modest size, not sequential access to files with sizes in the hundreds of megabytes each. To solve this problem, you could develop the application on a minicomputer or mainframe—the end product is the same—or you can equip the microcomputer with specialized hardware and software to support CD-ROM development.

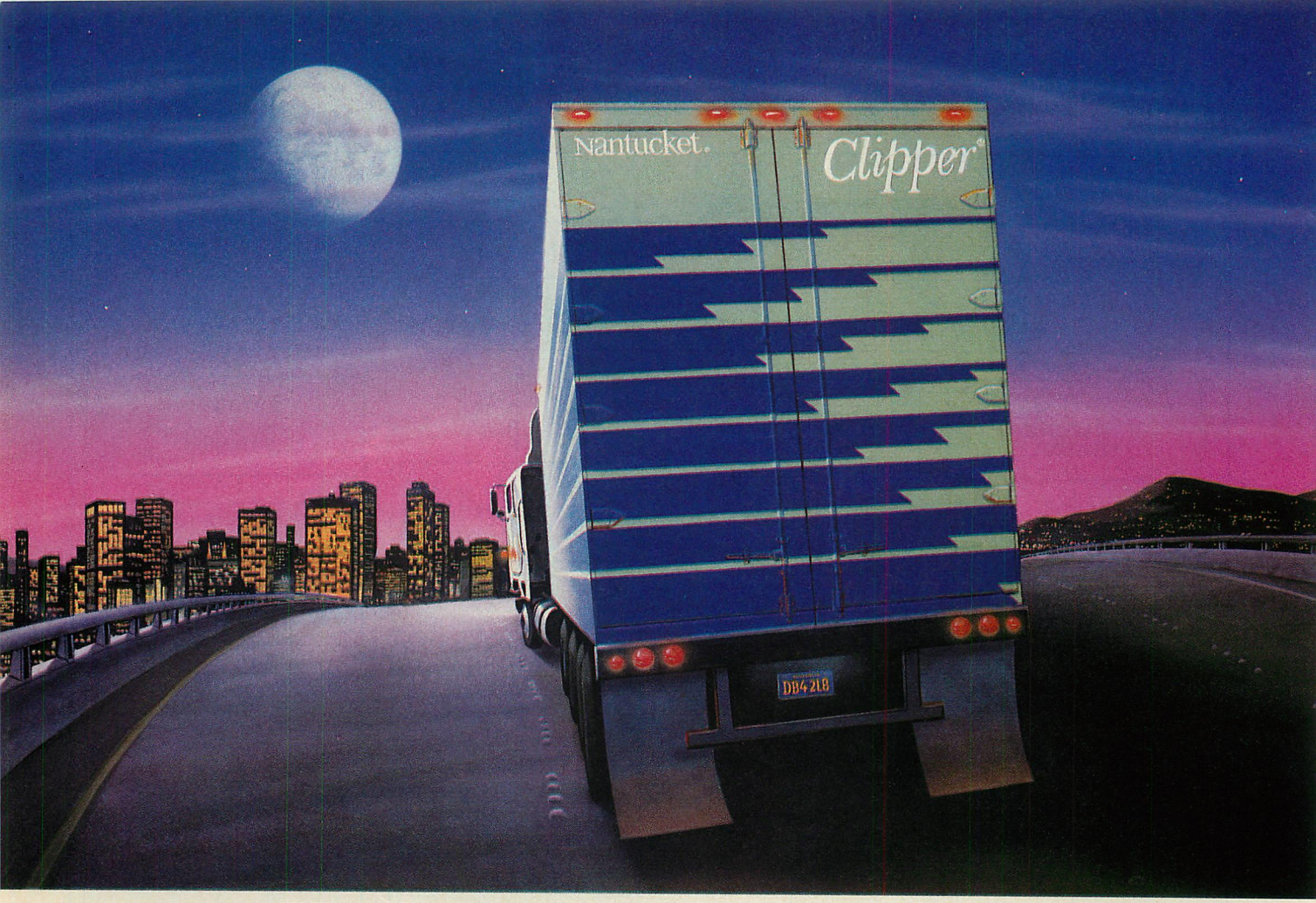
Fortunately, processing power is not an issue. Microcomputers offer the raw processing power found in much larger, more expensive computers. For example, a sample task to sort and merge 150MB of data destined for CD-ROM took 4.7 hours on a Compaq Deskpro 386, while a Burroughs 7900 mainframe did it in 30 minutes. The microcomputer took nine times longer—about one order of magnitude—but the cost of the machine is several orders of magnitude less than the mainframe. This trade-off (more time for less cost) is enough to recommend the microcomputer as a platform for CD-ROM data production.

FIGURE 1: ***Steps in Producing a CD-ROM***



Many of the activities shown are similar to those in the production of any information-based product, such as a book or a computer program. Other activities, especially those dealing with producing the master, are specific to the CD-ROM medium.

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Integrating the right storage devices and software into the hardware platform is the key. An acceptable authoring system should provide the environment outlined below.

STORAGE DEVICES FOR CD-ROM

A CD-ROM production environment requires a large magnetic hard disk (1GB to 4GB) that can be logically partitioned, independent of physical disk boundaries. This allows the development environment to be target-machine independent—the CD-ROM database will run under DOS, UNIX, or other operating system.

Ideally, the storage system should be able to hook up to these different operating systems simultaneously, perhaps even acting as a file server on a high-speed network so that multiple projects or individuals can access different data sets. The multimegabyte data files typically recorded on CD-ROM can make it impossible for one person to complete the editing task in an acceptable time frame. Making data accessible through more microcomputers permits task sharing.

The hard-disk drives integrated into a CD-ROM production environment must offer higher reliability than standard drives because the huge amount of data involved increases the chance of error. On a standard PC, data verification typically is turned off so that all writes are "blind." You assume that the data are written correctly by the fact the system does not return an error—but this assumption could be faulty because the system returns only the most catastrophic errors.

Generally speaking, one 20MB hard disk in one hundred has a bad byte—a byte that is read back differently than it was written. This is an acceptable error rate in the application world. However, this same probability translates into one in three CD-ROMs (assuming that each disk has a 600MB database) having a bad byte, which is not acceptable. Software that automatically verifies data blocks and reassigns any that are in error is the answer. Once a block is written, it is reread to ensure its readability; if it is not readable, the block is marked as permanently inaccessible and the data are written to a different area on the disk.

A CD-ROM production environment must produce disks with a file structure that the target machine can read. That structure is likely to be either a High Sierra Group (HSG) file structure or the International Standards Organization (ISO) 9660 file structure, the version of the HSG standard approved by the ISO (see the accompanying sidebar, "A Tree Grows in the High Sierra," p. 58).

According to CD-ROM mastering facilities, more than 95 percent of the data-set tapes earmarked for CD-ROM adhere to either HSG or ISO 9660 file structures. These two standards ensure that the data contained on the CD-ROM can be read across different operating systems and drives.

Accessing an HSG partition under DOS requires the Microsoft CD-ROM Extensions, a set of device drivers and terminate-and-stay-resident utilities that make the CD-ROM drive appear to DOS as a high-capacity block device. Vendors of CD-ROM drives license the extensions from Microsoft, adapt them to their hardware, and, typically, bundle them with their drives.

The authoring system should allow the integration of the hard-disk drives so they appear as one physical mass-storage device that belongs to the operating system. Next, this hard-disk storage must be separated into at least two partitions: a host operating system and a CD-ROM that conforms to some version of the HSG standard.

CD-ROM development under DOS requires circumventing the 32MB disk-size limitation so that the image of an entire 600MB CD-ROM can be kept in one DOS partition. Once the limit is gone, you can manipulate the entire CD-ROM data set with standard DOS commands and commercially available data-management packages, provided such programs can handle the volume of data typical to CD-ROM data sets.

Using a DOS partition that is the same size as the target machine enables you to develop the CD-ROM in an environment similar to the one in which the disk eventually will be read. In addition, the DOS partition serves as a staging area for the data while they are structured into the format that the HSG standard requires.

Certain limitations of the HSG format suggest that it is easier to manipulate the data in a DOS partition and then move them to an HSG partition. The HSG format is unusual among file systems because, for obvious reasons, file-write operations have not been defined or implemented. Furthermore, the directory structure and file allocation tables do not contain the information necessary to regulate the addition, removal, and replacement of a file or directory. The absence of these facili-

CD-ROM AUTHORING/PREMASTERING SYSTEMS

Following are companies and the products they offer as CD-ROM authoring and premastering systems. These products have not been tested by *PC Tech Journal*, and this list is provided only as a sampling of the CD-ROM industry.

Advanced Graphic Applications Inc.
90 5th Avenue
New York, NY 10011-7696
212/337-4200
DISCUS 1000
DISCUS 2001

Crowninshield Software Inc.
1105 Commonwealth Avenue
Boston, MA 02215
617/787-8830
MediaBase

Dataware Inc.
2 Greenwich Plaza, Suite 100
Greenwich, CT 06830
203/622-3908
CD AUTHOR

Meridian Data Inc.
4450 Capitola Road, Suite 101
Capitola, CA 95010
408/476-5858
CD Master
CD Publisher

Optical Media International Inc.
485 Alberto Way
Los Gatos, CA 95032
408/395-4332
deskTOPiX
macTOPiX
TOPiX CD-ROM Premastering/
Encoding System
TOPiX Software

OWL International Inc.
14218 N.E. 21st Street
Bellevue, WA 98007
206/747-3203
Guide Library System

Reference Technology Inc.
(Authorized U.S. distributors for
Elektroson Engineering Consultants B.V. of the Netherlands)
5700 Flatiron Parkway
Boulder, CO 80301
303/449-4157
CD-Simulator Level 1 Software
CD-Simulator Level 2 Software

—Linda W. Helgerson

A TREE GROWS IN THE HIGH SIERRA

A proposal for the logical file structure of a CD-ROM was developed by a group of companies meeting at the High Sierra Casino in Lake Tahoe, Nevada, in 1985. The original participants in what became known as the High Sierra Group (HSG) were Apple Computer, Digital Equipment Corporation (DEC), Hitachi, Microware Systems, Microsoft, Philips, Reference Technology, Sony, 3M, TMS, Videotools, Xebec, and Yelick.

The group's intent was to define a file system that would be tailored to the characteristics of the optical read-only medium, yet would still be acceptable to a wide range of operating systems running on a variety of computer hardware. Their work—which became known as the HSG proposal—was then submitted to the International Standards Organization (ISO). After some minor modifications and enhancements were made, the HSG proposal was adopted in late 1987 as ISO standard 9660. For the purposes of discussion, the final ISO standard is identical to the original HSG proposal.

The standard describes the organization of the physical structure of a CD-ROM (defined by its creators, Philips and Sony) into a logical structure of files and directories. The file organization is similar to the tree-structured disk directories in DOS and UNIX but differs in some respects due to the characteristics of the medium. The following is a summary of the file structure (for a full description, see "Patterning CD-ROM," Peter Jansson, July 1987, p. 162).

The data area of a CD-ROM begins with a volume descriptor that contains pointers to two directory tables (see the figure at right). One table is the *root directory*, which forms the base of the tree structure. As in DOS and UNIX, the root directory and each lower-level subdirectory can contain entries that define the location of files and additional subdirectories. The difference here is that CD-ROM allows no more than eight levels of directories.

In a tree-structured scheme, reading a directory located n levels below the root requires at least n disk seeks. Given the slow seek time of a CD-ROM, this is often unacceptable. Therefore, the HSG proposal establishes a more direct way of finding a directory at any level. The second table pointed to by the volume descriptor is the *path table*, which gives the physical location of every directory on the disk. The path table is designed to be read into RAM and kept there through all activity on a particular CD-ROM disk.

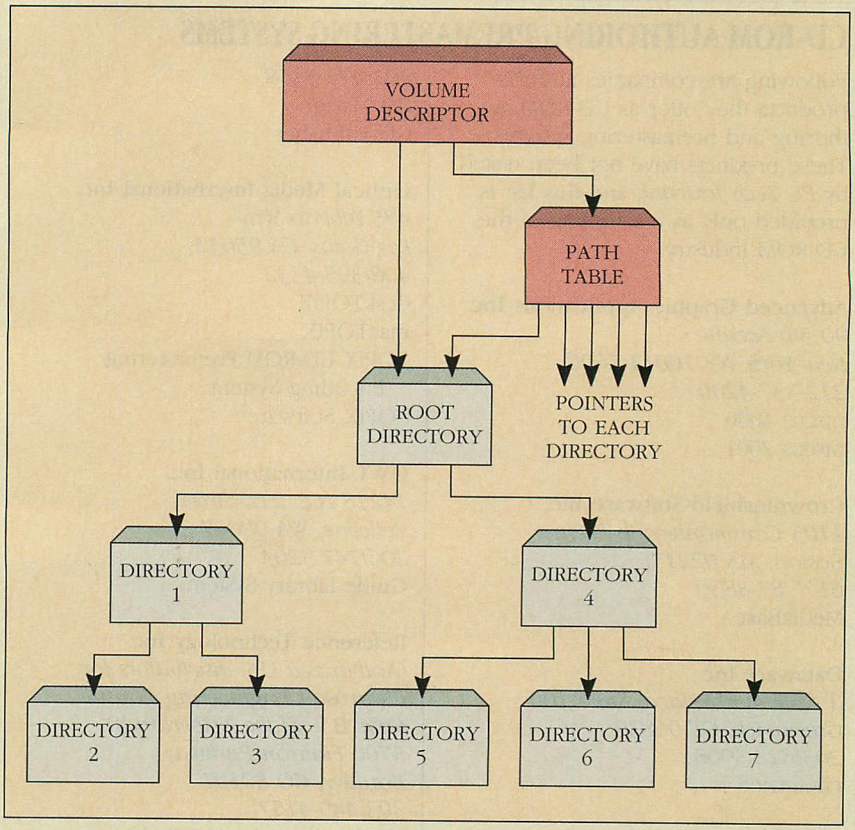
In effect, the disk contains two superimposed directory structures: a hierarchical structure defined by the root directory and its children, and a two-level structure defined by the path table. At any given point, the system provides two possible paths for finding a directory. Getting to a child of the current directory is most efficient through the tree structure, while accessing a directory contained elsewhere in the structure is most efficient through the path table.

The other distinguishing characteristic of the HSG standard is its dual encoding of numeric data in the directories. To facilitate the processing of directories by a variety of operating systems, all multibyte numeric values (for example, sector addresses and sizes of directories and files) are recorded twice, once with the least significant byte first (as used by most microcomputers) and again with the most significant byte first (as required by minicomputers and mainframes). This duplication improves the performance at the expense of disk capacity—a reasonable trade-off, given the large capacity and slow response time of a CD-ROM.

Although similar in concept to the DOS directory structure, the High Sierra format reflects some fundamental differences arising from the read-only nature of the underlying medium. For example, no provision is made for adding file names to directories or for dynamic growth of files into noncontiguous extents. Therefore, it is not feasible to develop CD-ROM databases in an HSG structure imposed on magnetic media. Instead, files must be assembled in a dynamic read/write environment and transferred only after all data are entered and the relative positions of the files are established.

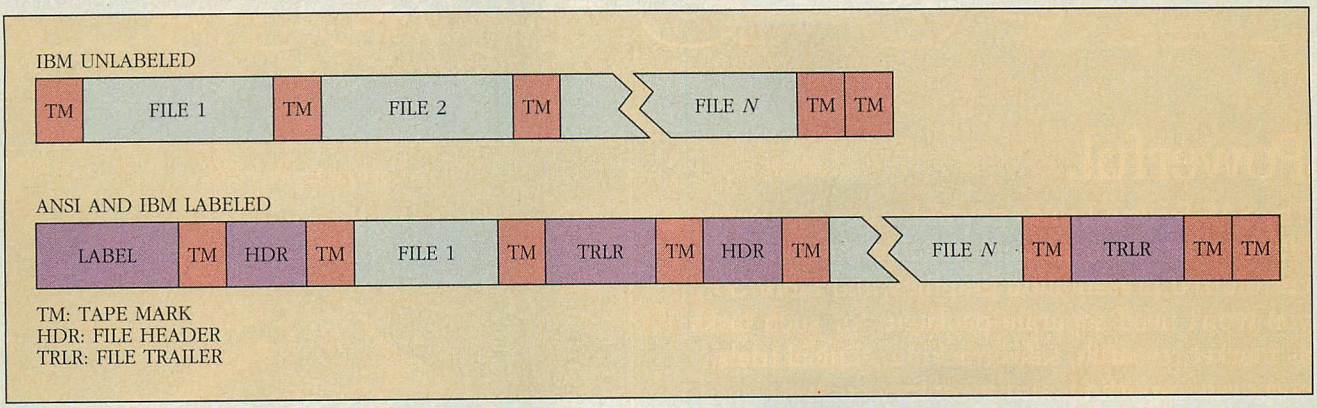
—Ted Mirecki

FIGURE: ***ISO 9660 CD-ROM Directory Structure***



Any directory in the structure can be reached either by traversing the tree beginning at the root directory (as in DOS and UNIX) or directly by means of the path table. The latter method minimizes disk seeks for directories at lower levels.

FIGURE 2: *Labeling Nine-track Tape*



Nine-track reel-to-reel tape formats are standardized on virtually all minicomputers and mainframes regardless of manufacturer. ANSI and IBM formats follow the same layout but use different character codes: ASCII on ANSI tapes, EBCDIC on IBM tapes.

ties causes problems when files and directories must be updated during development.

In addition to the DOS and HSG partitions, the CD-ROM developer might create a user-defined file access method (UDFAM) partition, which emulates direct access to the CD-ROM without benefit of file structure. Essentially, this partition contains the raw structure of a CD-ROM. It supports direct, sector-by-sector addressing of the 330,000-plus, 2,048-byte sectors on a CD-ROM. Thus, the developer controls the layout of the disk image and is responsible for specifying the location of the data.

A CD-ROM production environment also requires a reel-to-reel nine-track magnetic tape drive system. Although nine-track tape has been around computing for nearly three decades, in the microcomputer area, streaming-tape cartridges and high-density diskettes typically perform backup functions otherwise associated with reel-to-reel.

CD-ROM changes this scenario because more than 85 percent of all information earmarked for CD-ROM originates on a mainframe or minicomputer, so a tape drive is required to download the data into the PC-based authoring system. No other established electronic technology provides the large storage capacity, high data-transfer rates, low error rates, machine interchangeability, and inexpensive media of nine-track tape systems. On the other end of the process, the output of the authoring system is usually put on tape, because nearly all CD-ROM mastering facilities depend on nine-track tape as their input medium.

The most common formats for data on magnetic tape are IBM unlabeled, ANSI labeled, and IBM labeled (see figure 2). An IBM unlabeled tape is one in which the data sets (the IBM mainframe term for files) are separated by *tape marks*—also called *file marks*—which are lengths of tape written with a reserved magnetic pattern that is not used for recording user data. Two consecutive tape marks after the last file indicate the end of the reel. This format provides no information concerning file names, data formats, and whether a series of files extends over multiple reels.

An ANSI-labeled tape begins with a volume label formatted according to ANSI-standard X3L5/85-39T. Among the information in this label is the volume identifier and whether the volume is part of a multivolume set. The header preceding each file gives its name and format (fixed or variable records, record length, and block size). The file trailer indicates whether this is the end of the file or the end of the volume, with the same file continuing into the next volume.

The ANSI file name carried in the file header consists of 17 characters. Two methods are available for converting ANSI file names to DOS names. In the first, the download software uses the ANSI name if it is acceptable to DOS and notifies the user with an error code if it is not. In the second method, each ANSI file is displayed as it is read and the user is prompted to enter a DOS name.

An IBM-labeled tape coincides exactly with an ANSI-labeled tape, except that all labels and data are written in EBCDIC, the character-encoding scheme used on IBM mainframes, rather than in ASCII. EBCDIC defines 256 characters using an eight-bit code, while ASCII has 128 seven-bit characters. Downloading an IBM-format tape to a DOS system requires translating from EBCDIC to ASCII; how this is done depends on whether the reverse translation needs to be performed.

In a straight EBCDIC-to-ASCII translation, the EBCDIC characters that do not map directly to ASCII are output as either blank or binary zero. This method results in a straightforward ASCII file with all printable characters, but it loses some information and makes it impossible to translate the file back to its original form. The alternative method, EBCDIC/FOX-to-ASCII translation, represents EBCDIC characters without counterparts in standard ASCII with the high-order extended ASCII characters defined by IBM for the PC. The resulting ASCII file contains some high-order graphics characters, such as the accented letters and line-drawing characters, making it slightly less convenient for editing purposes than the clean ASCII format of the first method. However, EBCDIC/FOX translation allows translating back to EBCDIC without losing information.

In attaching the various peripherals necessary to an authoring system, consider ways to minimize use of the PC's limited expansion resources. When integrating tape and hard-disk drives into the CD-ROM development environment, the obvious solution—two separate host adapters, one for the tape and one for disk—is not necessarily the best. This approach limits the storage subsystem to only those microcomputers with two free direct-memory-access (DMA) and interrupt channels.

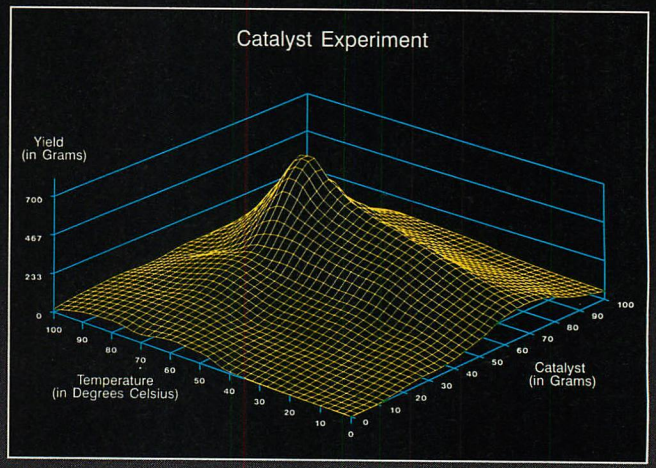
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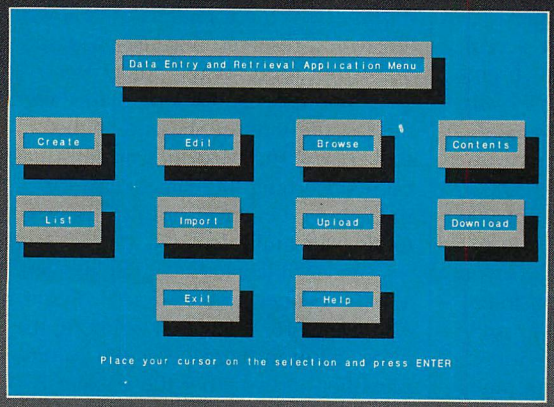
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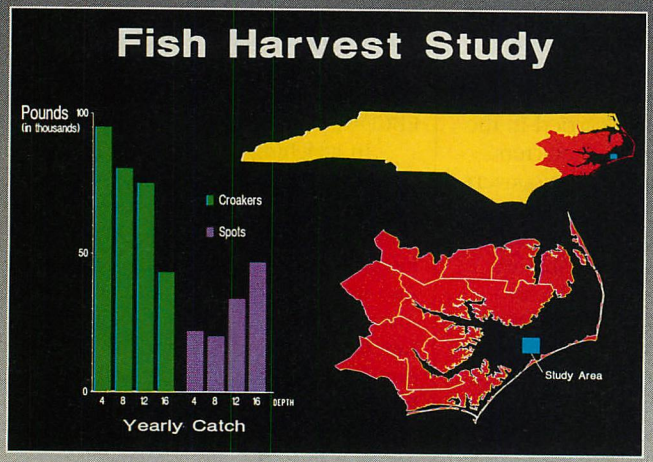
Read data in any format from any file, and manipulate data with common-sense statements like SORT and MERGE. Take advantage of superior analytical tools—from simple frequency counts to advanced regression. Then report your findings in tables, charts, maps, and more.



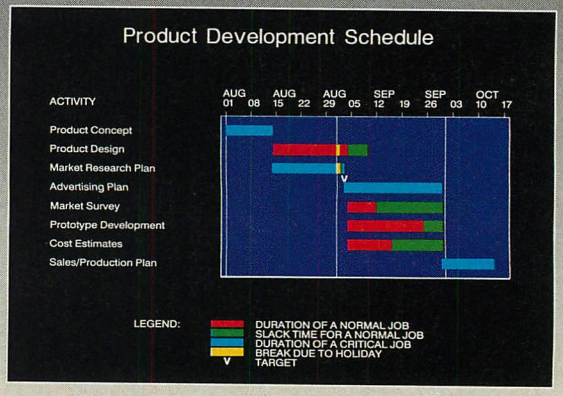
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tion can have long-term transfer rates of better than 500KB per second and a burst capability of more than 1MB per second, compared with the 250KB rate of the typical ST-506 hard disk.

In addition to a large, magnetic hard-disk resource and a nine-track tape drive, a CD-ROM production environment requires specific software. Programs need to address the characteristics of the medium that arise from its large capacity and read-only nature. Working with multimegabyte files, thousands of files per directory, and tens of thousands of files on a single volume creates situations in which many standard PC programs do not function satisfactorily, if at all. DOS file handling, for example, slows considerably when directories exceed several clusters (64 to 256 file entries) in size.

It is helpful if the mastering system provides specialized utility programs, to facilitate CD-ROM development. One example is a utility to compact data to eliminate unused space. When DOS erases a file, only the directory entry, which indicates the file's presence and location, is erased. The area occupied by the file can be reallocated on a subsequent write, but the actual data comprising the file are not erased. When data are transferred to CD-ROM, an image of a particular section of magnetic media, including unused areas, is transferred. The unwanted information should not only be erased, but other data should be moved to fill in the void.

PREPARING THE DATA

To streamline the data-preparation process, data should be in a standard format amenable to indexing. The various methods for producing documents—word processors, operating system editors, typesetting programs, proprietary programs—make this task complex. Enter the Standard Generalized Mark-up Language (SGML). Developed by the Association of American Publishers, SGML is a set of principles for the descriptive mark-up of manuscripts. It standardizes the various parts of a manuscript to be emphasized or identified, including:

- Definitions of types of documents.
- Specifications of elements that are incorporated in the document.
- Creation of descriptive tags for these elements.

Straying from standard mark-up rules often means custom-building a program to filter nonstandard symbols or retagging the text manually—both costly endeavors. Many service companies can convert data into an SGML format. After converting the data to a CD-ROM data-preparation format, concentrate on structuring the database and indexing it for end-user retrieval. Many of the database retrieval packages available are compatible with SGML format.

Retrieval software comprises three parts: the build engine, the retrieval engine, and the user interface. The build engine develops the data structures, such as indexes and linked lists, that support the desired retrieval features. Retrieval engine software is distributed to the end user as the means to access the information. The user interface guides the user through the information-retrieval process.

Many applications, such as the storage of digitized graphics images, can overwhelm even the vast capacity of a CD-ROM. If, for example, a graphics image occupies 500KB, a CD-ROM can store 1,200 pictures. Storing more than this involves two alternatives: trading error correction for data space or employing data compression.

Sound disk geography is a matter of common sense: avoid creating thousands of small files that lead to time-consuming seeks.

Each CD-ROM sector is divided into three or four fields. The first is a 12-byte synchronization field used by the read hardware; the second is a 4-byte header carrying the sector identification and the recording mode. Recording in mode 1 offers two more fields: 2,048 bytes of user data followed by 288 bytes of error-correction code. In mode 2, user data occupy 2,336 bytes, with no error-correction field. Mode 2 is a good choice for raster graphics because it increases capacity by 14 percent with little penalty. Losing one bit or several in an image affects only one pixel, which is acceptable; however, an error of one byte is unacceptable for text or numeric data.

Compression calls for the removal of insignificant or redundant image information. For text, removing white or blank space offers only a small reduction in size but provides very fast decompressing speeds. Typically, white-space compression results in a file that is 95 to 98 percent of the original, and loads in about the same time. Symbol replacement reduces common long words to shorter symbols, such as "number" to "#." This reduces file size by as much as 25 percent. For graphics images, other more complex techniques, such as Group IV (used by facsimile machines), achieve higher compression ratios at the cost of more processing time for decompression.

Because CD-ROM shares the underlying physical disk structure with CD audio, it can combine storage of digitally encoded audio with data. The CD audio standard defines a sampling frequency of 44.1 KHz and 16-bit quantization (converting discrete sounds into digital values). At full fidelity, an audio-only disk has a playing time of 74 minutes; a data-only disk has a 600MB capacity. The two can be combined in any amount, for example, 37 minutes of audio and 300MB of data.

If your application does not require CD-quality sound, you can increase the disk's audio capacity by using a lower sampling rate (introducing some distortion), a lower quantization (resulting in lower dynamic range), or both. Before pursuing this option, make sure that the CD-ROM drives intended to read the disks have audio capability and support the lower-fidelity scheme. In addition, audio can be compressed, much like graphics. Adaptive delta pulse code modulation (ADPCM) has emerged as the de facto standard audio-compression technique in the industry.

Remember, however, that audio is not randomly accessible with the resolution of computer data. The CD audio standard was not designed to go to a particular block of audio data, but rather to go to general locations on the disk—the beginning of a song, for example. The publisher marks these areas through flags. The CD audio standard allows for 99 different tracks of audio information and 99 different segments within each as searchable points. Also, the drive requires a delay of 1 or 2 seconds when switching between audio mode and data mode to resynchronize; thus, moving rapidly between audio and data is not particularly effective on a mixed-mode disk.

Once the database is designed, you can apply disk geography techniques to locate physical files on the disk to minimize seek times and optimize performance. Sound disk geography is a matter of common sense: avoid creating thousands of small files that lead to time-consuming seeks of



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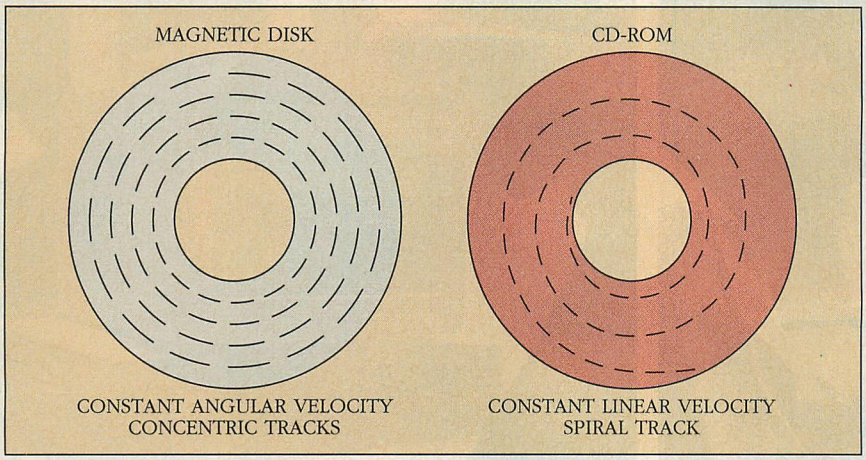
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FIGURE 3: ***Disk Geometries***



At constant angular velocity (CAV) shown at left, all sectors on the disk are in concentric tracks and subtend the same angle. At constant linear velocity (CLV) shown at right, all sectors are in one continuous spiral and are the same length.

each file. Instead, build larger files that are related and likely to be used together. Thus, slow seeks are replaced by relatively fast sequential reads.

For example, if a disk contains 1,000 photos of automobile parts, you can improve disk geography by making 10 files that each holds 100 pictures instead of 1,000 files. In this scenario, you add an index file that, for each picture, specifies the data file containing it and an offset from the beginning of the file to the picture. To read in a specific picture, the system seeks to the beginning of one of 10 files, then sequentially reads through the data until it reaches the beginning of the desired picture. This will improve performance in either of two cases: first, if the pictures in one file are related and often are retrieved one after another; second, if the time gained in processing a directory with 10 files as opposed to 1,000 is greater than the time lost in sequentially reading the larger files.

TESTING AND SIMULATION

Final performance of the CD-ROM database depends on many design decisions. Where should large files go? How many files should a directory have? Should data be compressed or combined into larger files? What partition sizes should be used? These questions must be answered before the database is committed to mastering. Testing various parameters of the build/retrieval engine and data geography helps establish the combination that produces the best performance.

Note, however, that performance depends not only on the database design but also on the drive hardware. Two distinguishing drive characteristics are built-in caches and speed differences in seeking forward and reverse. The average seek times of current CD-ROM drives approach those of the hard-disk drives of three years ago.

The fact that CD-ROM drives are constant linear velocity (CLV) devices complicates testing a CD-ROM with magnetic media. In a CLV device, each sector of data, regardless of its radial position, moves over the head at the same speed. The disk's rotational speed changes as the head seeks in and out. In contrast, a constant angular velocity (CAV) device—such as a magnetic disk drive—maintains constant RPM, so the outer tracks pass the head faster than the inner ones.

Another basic difference is that the sectors on a CD-ROM are arranged in a continuous spiral; on a magnetic disk they are in concentric tracks (see figure 3). When the read head of a magnetic disk is on a given track, it can reread the same track without changing position. On a spiral track, the head must move outward and resynchronize itself with the spiral. Because the disk spins at less than half the maximum speed when reading near the outer edge, it takes longer for the desired data to reappear. As a result, access time is partly a function of the radius at which the read occurs.

A third difference is the transfer rate: about 176 KB per second (KB/s) for CD-ROM versus 250 to 300 KB/s for a hard disk. Testing a CD-ROM database on a magnetic disk verifies data integrity and indexing accuracy, but it does not reliably gauge the retrieval speed on the optical medium.

Hardware/software simulation tools that can duplicate the performance of a CD-ROM drive on magnetic disks overcome these differences. Such tools account for the physical characteristics of the CD-ROM medium, of a particular drive, and of the variations in access time due to position within the database. Using these tools, the developer can produce results that duplicate those obtained with an actual pressed disk. The simulation process shows exactly how the database will perform on CD-ROM. One useful measure of performance is the number of seeks needed to access given data: three seeks per read is acceptable.

MASTERING CD-ROM

A CD-ROM application requires as many as 6 nine-track tapes to store the data. Most mastering facilities recommend sending 2 tape sets to ensure data integrity; thus, the CD-ROM production environment should be capable of producing duplicate tape sets.

The data submitted are used to produce a glass master. In the recording process, a high-powered laser burns microscopic pits, representing the 0s and 1s of the binary data, into a glass disk. From this disk, metal stamps are produced in a series of electroplating processes. Depending on the requested turnaround time, mastering costs range from $3,000 to $10,000.

The distribution disks are created from high-purity polycarbonate plastic that is fed into high-precision, injection-molding machines. Correct timing and temperature are crucial, so these robotic-assisted presses monitor the operating environment continuously. In the final step, the two halves of the mold are pulled apart to reveal the disk. As in many production processes, a higher unit volume results in significant savings: pressing 500 disks costs about $5 per disk; pressing 5,000 cuts the cost per disk in half.

A technology coming into its own, CD-ROM production will grow and change, evolving into a more sophisticated medium. It is best suited for large bodies of stable data that require wide distribution. Developing a CD-ROM application is not simple, but if the data and end-user market fit the bill, CD-ROM is an increasingly sensible publishing alternative.

Linda W. Helgerson is president of Diversified Data Resources Inc., a consulting firm in Falls Church, Virginia, that specializes in optical storage technologies. Fred P. Meyer is president of Meridian Data Inc.



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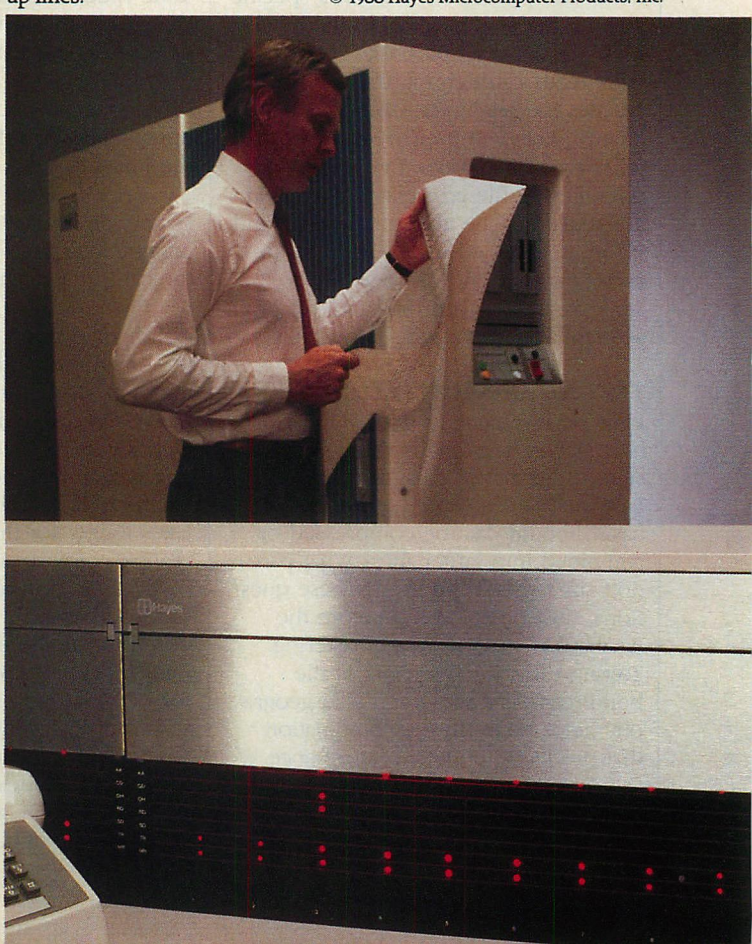
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The vast expanse of storage capacity on a CD-ROM is a challenge to map out. It requires a new set of indexing and retrieval methods.



In Search of CD-ROM Data

LINDA W. HELGERSON and
HARVEY G. MARTENS

The benefits of CD-ROM are undeniable—not the least of which is its massive storage capacity. One disk can store the data contained on almost 1,500 360KB 5.25-inch magnetic diskettes. This immense scale, however, can be overwhelming.

The environment for CD-ROM (compact-disk–read-only memory) can be a vast wilderness to an indexing and retrieval system designed for magnetic storage media. Algorithms that were developed for files of less than 1MB residing on disks of less than 100MB often break down in the CD-ROM environment, where 10MB to 20MB of data could be just one of many files on a 600MB CD-ROM. Moreover, retrieval methods that require operating-system services cannot be used in the CD-ROM environment if the operating system does not support data volumes of this size—as MS-DOS does not.

Next to storage capacity, the most significant factor for the systems developer to consider when designing an indexing system for CD-ROM is the basic difference in the physical format of optical and magnetic storage media. A CD-ROM is not an optical version of a magnetic disk. Its closest equivalent is the phonograph record.

The data layout on a CD is not optimized for random access, but for sequential read out in realtime, a requirement imposed by CD audio, which established the optical format. Head seeks, therefore, take much longer on CD-ROM than on a magnetic disk, which was specifically designed for random access. While an average head seek on a magnetic hard-disk drive might take 30 milliseconds (ms), on a CD-ROM it may require a full second—practically an eternity in the microcomputer world. As a result, index structures requiring multiple seeks to read portions of the index file—such as B-tree indexes, commonly used in magnetic databases—do not perform well on optical media.

Early CD-ROM retrieval programs often were converted from programs designed for magnetic media. Multiple seeks of the database were avoided by downloading the index for the part of the database to be searched onto a hard disk, and then continuing the typi-

PHOTOGRAPHY • STUDIO 65 BACKGROUND SCENE • THE IMAGE BANK

cal multiple-seek method of retrieving data. Although this works, it requires a large amount of free hard-disk space, which could be an unacceptable limitation for many users.

Many CD-ROM retrieval engines still employ this technique, and it is indeed appropriate for some applications. The newer versions of these earlier engines or later retrieval programs developed specifically for CD-ROM, however, use techniques to circumvent multiple seeks of a database.

Another difference between CD-ROM and magnetic storage is the very nature of the database. Because the database stored in a magnetic environment is dynamic, its index also is constantly changing. Thus, in addition to simply reading the index, the retrieval engine must also update and rebuild the index as data are added and deleted. The indexing system also must allow room for the index to grow.

In contrast, because a CD-ROM database is, by definition, static, its index does not change. Once completed, no additional space for growth is required. Because of this, the CD-ROM index is more compact and can be searched more efficiently. A typical CD-ROM indexing system consists of two parts: an indexing program that builds the index and a retrieval program. The former is used only in development; the latter is distributed with the finished application.

THE DETAILS

Data stored on both magnetic and optical media are organized into fixed-length sectors. CD-ROM uses 2,048-byte sectors, while operating systems for magnetic disks use various lengths—DOS, for example, uses 512-byte sectors. The primary difference between the two media is in their geometry—how the sectors are arranged on the surface of the disk and how they pass over the read head.

On magnetic media, sectors are on concentric tracks and read at a *constant angular velocity* (CAV), which means that the disk spins at a constant rotational speed. CD-ROM sectors, on the other hand, are on a continuous spiral track and are read at a *constant linear velocity* (CLV)—the disk spins faster when the head is near the center than when near the edge (see "CD-ROM Publishing Strategies," Linda W. Helgerson and Fred P. Meyer, this issue, p. 52).

Data on a magnetic disk are addressed by track and sector numbers. Each track is a fixed radial distance, and the head can move to it directly where it remains stationary while reading the data passing by. The amount of data in each track, however, is limited, and the head must soon go to another track. Therefore, magnetic disk hardware and software are optimized for multiple, rapid seeking and reading of small blocks of data.

On a CD-ROM, data are addressed only by sector number. To find a given sector, the head traverses the disk radially to the approximate vicinity, while the mechanism adjusts the speed of rotation to maintain a constant linear velocity past the head. Once the head reaches the approximate location, it waits for the disk speed to stabilize, resynchronizes with the spiral, and follows it to the desired sector. When reading data, the head does not remain stationary but follows the spiral like a phonograph needle (unlike a phonograph record, however, a CD is read from the inside out). The head can read all the data to the end of the disk with no further stepping.

The key to efficient CD-ROM access and retrieval is to make as few seeks and read as much data at one time as possible.

The key to efficient CD-ROM access is to make few seeks and read as much data at a time as possible. Because of the high data density of the optical medium, more data are closer to the read head than on magnetic media. Once the approximate location of the data is established, more data can be transferred with less time-consuming head motion. The motion necessary to follow the spiral, and the adjustment of rotational speed as the radius of the spiral increases, are gradual enough not to cause delays.

In addition to a slower seek time, CD-ROM also transfers data at a slower rate than the typical magnetic disk—170 KB per second (KB/s) versus approximately 300 KB/s, respectively. Despite this, CD-ROM can outperform magnetic disks in certain situations. The obvious situation is when the database overflows the capacity of a hard disk. Reading one CD-ROM is quicker than mounting removable disk volumes or erasing and reloading fixed disks. A less apparent example is when transferring amounts of data greater than one track. Here, the CD-ROM is faster (excluding the initial seek) because the hard disk must step from track to track.

CHOOSING AN INDEX

The first step in choosing an indexing and retrieval method is to examine the database. What to look for depends on the application and the target audience, but items to be considered should include the following: What kinds of data are there (text, numeric, digitized graphics, or audio)? What is the density of data compared with delimiters, white space, noise words? What is the format of the data? Should the format be changed for use on CD-ROM? What kinds of hierarchies, if any, will work with this kind of data? Are the fields delimited? Are they fixed length or variable? Do the data contain tags, which are predefined identifiers at the beginning of each field? If not, should tags be added for faster processing?

Getting answers to these questions can involve performing an automated analysis of the database or test processing with various indexing programs. Because of the large size of a typical CD-ROM database, however, performing an analysis on the entire database usually is not practical. Instead, a representative sample, constructed with statistical sampling techniques, must be extracted and analyzed.

End-user performance is another major consideration when choosing an indexing and retrieval scheme. Performance, however, is judged by more than just the time it takes to satisfy a query. Qualitative measures include ease of use, power, flexibility, and suitability for the target audience. Moreover, developers need to focus many CD-ROM applications for two distinct types of end users: the expert searcher, such as the professional librarian, and the casual user who is unfamiliar with the contents of the database, how to formulate a search query, or how to operate a computer. Ideally, a CD-ROM product will be suitable for both groups, even though the needs of each are very different. Ease of use, for example, is a must for the casual user but not for the expert, who desires speed and power above all.

Designing a satisfactory system for the occasional user is more difficult than for the expert, thus requiring extra effort if the target audience includes the former. The occasional user is demanding and impatient, with little

or no time to spare for anything other than the briefest of queries. For this group, the retrieval procedure must be easy to learn, easy to use, fast enough for the shortest of attention spans (no more than a four-second search, preferably two seconds), and must have utterly clear directions as to the steps to take next or available options.

Context-sensitive help was traditionally assumed to be a key requirement for a beginner's application interface. But no matter how helpful, a help screen distracts users from the main task, forcing them to retrieve information from a help file instead of from the database of interest. Instead, current practice calls for displays that are self-sufficient and as "intuitively obvious" as possible, meaning that the user automatically knows what to do next.

A technique often used to keep the novice user's attention from flagging is to include entertainment. Little disk icons whirring away on the monitor, odometers denoting the number of records found, and elaborate unveilings of logos are fun the first few times, but they quickly grow stale and are counter-productive if the intent is to turn occasional users into frequent ones. These devices are used less and less as search software matures.

The single most important criterion for the occasional user is consistency. Certainly the command structure should be consistent—if the F1 key calls up the help screen at the main menu, it should do the same on every other menu—yet some CD-ROM products still do not conform to this seemingly obvious principle.

Other irritating inconsistencies are possible. For example, the response time for various searches should be consistent. The natural tendency is to display data as fast as possible. Given the different kinds of searches, retrieval times differ. It is disorienting for the occasional user to receive some responses instantaneously but not others. This lack of cadence disrupts concentration, particularly for those not familiar with conducting a query. One way around this is to analyze the most probable sequence of operations in the searches occurring most frequently and to provide short-cut methods that build in as many operations as possible into the fewest number of user actions.

Quantitatively, performance is measured not only by the response time, but also by how closely the software approaches the ideal of retrieving all of (and only) the records relevant to a particular query. Three common

FIGURE 1: ***Relevance***

```
Given
n(t) =  the number of records in the database
        that are indeed relevant to the search
n(r) =  recall, the number of records found
        by the search
n(d) =  the number of retrieved records that
        proved to be relevant

n(d)
---- x 100 = relevance percentage
n(t)

n(d)
---- x 100 = precision percentage
n(r)

Example: Suppose that a query retrieved 90
records. Of these, 18 were rejected as
irrelevant, leaving 72 relevant records.
Further study indicated that the database
contained 120 relevant records to the search.

Recall    = 90 records
Relevance = (72 ÷ 120) * 100 = 60%
Precision = (72 ÷ 90) * 100 = 80%
```

Performance includes not only response time, but also efficiency in finding the data to satisfy a query.

numeric measures of this capability are *recall*, *precision*, and *relevance*. Recall is the number of records retrieved by a query, precision is the fraction of the retrieved records that are truly relevant to the search, and relevance is the ratio of the number of relevant records retrieved to the number of relevant records actually present in the database. Figure 1 is an example of how to calculate these measures.

Finally, consider the characteristics of candidate software packages. CD-ROM is a young industry and internal publishing is just becoming a reality, so there is not the body of experience with software vendors that exists for magnetic media. Therefore, when considering indexing-and-retrieval software, you should look at the answers to these questions closely: Does the software program have documentation? Is it complete? Useful? Are the build-and-retrieval facets of the program debugged? Has the vendor had any prior experience using the program as a build-and-retrieval package for CD-ROM? Has the software producer made many CD-ROMs? How well have they been received? Do they work? How long does it takes to index a small database? A large database? Who says so, and can they prove it? Has the indexing program ever been used on an actual file of more than 500MB? Successfully? Again, who says so, and can they prove it? What is the stated overhead for the index? Will this overhead rate limit the amount of data that can be stored on the disk? How much technical support does the vendor supply? Who (name, organization, and telephone number) has purchased and is using the program now for CD-ROM production?

INDEX AND FILE STRUCTURES

Because the most efficient method of retrieving data from a CD-ROM is to have as few seeks as possible to large records, the optimal search should require only one seek to the index file and only one seek to the data file. Some CD-ROM index methods based on magnetic database technology speed up multiple-disk seeks by minimizing seek distance instead of minimizing the number of seeks. These are still inefficient because a head seek is still very time consuming, regardless of how close together the seeks are.

The characteristics of the medium are just one factor that affects the indexing method. Another element is the type of data, which dictates the database format, which in turn dictates the type of index structure. Whereas most magnetic databases use fixed-length records with a relatively small number of keys per record, most CD-ROM databases need variable-length records and the ability to search on any field of a record. The most common approach to this is the *inverted file*.

A data file that is not inverted consists of a set of records, each of which contains a collection of fields or attributes. In a full-text database of documents, for example, each record might be a document consisting of a collection of words. The index to this database, called an inverted file, contains a record for each attribute value; each such record contains a list of pointers to locations in the database where that value occurs.

A related approach is to organize the list of pointers in a vector. The following entry, for example, indicates that *text* occurs once in record 1, does not occur in records 2, 3, and 4, occurs three times in record 5, and so on:

text (1, 0, 0, 0, 3, 0, 2 . . .

The retrieval software can mathematically manipulate this type of representation to compute word frequencies or *proximity functions*, or how close two words appear. Vectors occupy large amounts of space, but they are sparse and therefore lend themselves to data-compression techniques.

Once an index structure is chosen, the developer must organize the index itself for efficient searching. The B-tree

structure is unsatisfactory for CD-ROM because it consists of multiple levels of indexes to other indexes, requiring many accesses just to find the pointer to the data. With CD-ROM, the most efficient approach is to read as much of the index at a time as possible, and perform searches in memory. A limited number of levels of indexing is acceptable, however, if the top-level portion is kept in RAM or downloaded to a magnetic disk.

In the optimum case, the top-level index in RAM points to the location of the search word in the inverted file, which in turn points to the locations of the search word in the database. Figure 2 illustrates one common approach. The inverted file is indexed on the initial letters of each word, two in this example. To find a word in the inverted file, the retrieval program looks up its first two letters in the top-level tree-structured index, then seeks the disk address found there. From there, it reads sequentially until it encounters the desired word.

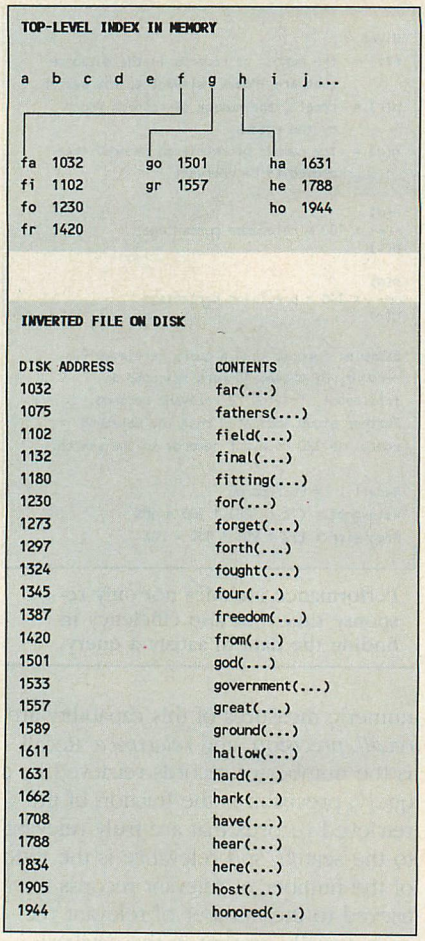
For an inverted file of a given size, the developer can reduce the amount of data that must be read sequentially by increasing the number of entries in the top-level index—at the cost of tying up more RAM—by indexing on more initial letters.

Because text databases are the most common CD-ROM application, most indexing schemes use some form of word search. Many text databases use the full-text index in which every word occurring in the database has an index entry. Because CD-ROM has such a large capacity, the overhead for a full-text index can fit comfortably on the disk along with the data file. Overheads the size of the database or even larger are common for some full-text indexing schemes. A 300MB database with an index overhead of 100 percent still fits on a single CD-ROM.

One problem with full-text indexing is that the relevance and precision of a search depend a great deal on the accuracy of the query. Searching for common words yields a high recall (many records) but low precision (few relevant ones). Boolean logic, especially the AND operator, can reduce the number of records retrieved. Inexperienced users who are unfamiliar with this technique, however, may use it incorrectly. Using the OR operator instead of AND, for example, increases the number of records retrieved.

A variation of full-text indexing is to eliminate *stop words*—words that carry little useful information (a, and, the). The developer must carefully tailor the list of stop words to the intended use of the database. Eliminating the word "a" from the index seems reasonable, unless the user wants to search for the phrase "vitamin A."

FIGURE 2: *Inverted File*



In this type index, the top-level index structure in memory points to the disk location where each two-letter combination begins. A desired word is found by reading sequentially from that point. If RAM space is sufficient, the average distance of sequential reads can be reduced by indexing on more than two initial letters.

Indexing on selected *key words* is another alternative to the full-text index and has been used successfully in bibliographic databases for many years. An expert reviews the documents and assigns one or more key words that clearly categorize the information contained in each document. Although this is an efficient method of both indexing and retrieval, the assignment of key words cannot be automated—the documents must be preprocessed by a person with expertise in the subject matter. Key words should be assigned to documents as they are written or added to the database; it is not practical to do this as part of the process of preparing the data for CD-ROM.

An indexing method related to the key-word technique uses *common phrases*. The terminology of most databases is related to a particular industry, profession, or service. (The military, for example, is notorious for acronyms.) Computer people have a language all their own, as do lawyers and doctors. These terms and their relationship to one another are often important enough to merit special attention: the developer can build a table of common terms for a given database or an index of whole phrases in addition to each word. Unlike the key-word method, processing can be automated, with software building the index.

Several techniques can enhance word-search retrieval methods. *Cross-referencing* is a secondary search method often used with text databases. Once a search retrieves some records, the user may want to look at other related records. Cross-referencing provides a direct path to related information in the database without another pass through the index. Typically, cross-reference pointers reside in the data records, not in a separate file.

Word frequency is a technique to help the user formulate effective search requests. A word that occurs rarely in a database can be far more valuable in identifying specific information than a word that occurs hundreds of times. The word count can be stored in the index structure and displayed to assist the user in formulating queries.

Words that often appear together are considered *adjacent terms*. A retrieval system that provides for adjacency allows the user to search for ad-hoc phrases, even if they are not phrases in the index. Adjacency is a special case of *proximity determination*. Simply put, the searcher can use the proximity of words to help eliminate irrelevant references. Rather than searching for the word "patient," for example, the user could look for only those references of the word that appear within a specified distance from the word "cancer." The user must be able to specify the distance between the two words in absolute or relative terms—such as the same document, paragraph, or sentence (or adjacent sentences), or separated by no more than a specified number of words.

A specialized thesaurus or glossary of terms in the index also improves the efficiency of the word-search index. In addition, incorporating a thesaurus into

the retrieval software allows users to look words up and incorporate the additional terms in a search in order to increase the number of records retrieved. A glossary, for example, might indicate that "oncology" is a good term to use along with "cancer" in a search of a medical database.

Truncation, another type of word-search enhancement technique, involves searching for part of a word. The searcher enters the portion of a word and indicates with a wild-card character that any other characters may satisfy the search. Most common in CD-ROM systems is right truncation, where various endings from a word stem are included. To find all words with the prefix "micro," for example, the prefix is entered, followed by an asterisk. All words with this prefix will be identified by the system, and the search will be expanded considerably.

Lack of attention to plurals and endings variations in an English-language search can often affect a search negatively. Singular or plural, -ing or -ed suffixes, uppercase, and other similar characteristics can be added or removed from the index. Some systems display the index in alphabetical sequence. With this method, it is easy to see the different endings and select only the terms that meet a predetermined criteria.

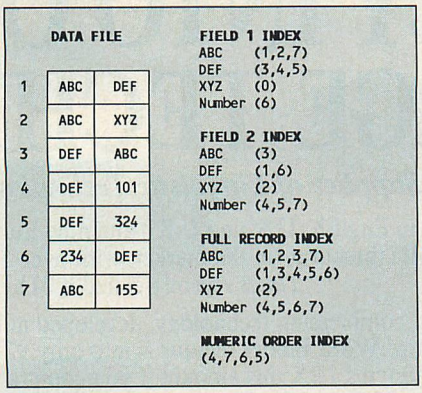
Another variation of truncation are *word fragments*, which can help the user find classes of words. Searching a scientific database is a good example because the terminology can contain long and complex words. The search process becomes more effective if the user can parse these complex terms to create word fragments that can be searched independently. For example, in a chemical database, the user may search for words ending in "ylene" or containing "nitro."

Another factor that affects the structure of the index is the total size of the database. In instances when the database exceeds one CD-ROM and data from two or more CD-ROMs are required to complete a search, problems for both the database developer and the user can occur. Certainly, it is most obvious to try to control what data are on which disk for purposes of indexing and retrieving data. In cases where more than one CD-ROM must be accessed in order to complete a search, dismount-mount software is required in addition to the standard indexing algorithms.

If all disks in a set are not produced or distributed at the same time, the user must have access to a high-level magnetic index of the entire set that can be updated automatically at local workstations. Assuming that at least some of the users are not familiar with computers, then any such manipulation at the command level must be avoided; index updating must be automatic and transparent.

One way to avoid these headaches, of course, is to insist that such a CD-ROM product be used simultaneously on multiple CD-ROM drives. Retrieval programs for multiple-disk sets are very different for many drives used simultaneously versus a single drive. Including the capability to handle both situations makes an application more attractive to a wider variety of users.

FIGURE 3: ***Search Points***



Searching on several fields requires a separate index for each field. In a database with many fields, the developer must balance the utility of multiple search points against the increased overhead and greater complexity of formulating the queries.

SEARCHABLE POINTS

In a database with records divided into attributes or fields, each attribute a user can search is called a *searchable point*. Each point requires a separate index, as illustrated in figure 3. With the index structure shown, the user can search for records with a particular text value or any numeric value in only the first field, in only the second field, or in either field. In addition, the numeric index provides a numerically sorted order of the records that contain numeric values.

The database developer may be tempted to provide the capability for searching on every field. This may not be desirable for two reasons. The overhead involved may be excessive, and too many options may be more confusing than useful—especially to the novice. It is better to provide two levels of searchable points: the most frequent search variables for the common mode of searching, and less obvious ones for secondary menus used in refining searches or for expert mode.

On the other hand, with too few searchable points, the user can easily miss important search criteria or become frustrated with the lack of options. Designing the database for optimum multipoint searching is a goal of all developers—accomplishing it is another matter entirely. Proper design of the user interface is one technique for easing the burden on both user and retrieval engine. For example, the interface might allow the user to specify search criteria through a series of interactions instead of all at once. The searcher can retrieve the desired data by a process of refining successive queries, allowing both the system and the user to build on previous results.

Customizing the user interface for each database is also a useful strategy. Using terms specific to an audience increases the speed of user understanding and decreases the number of times the user must attempt a query before getting the desired results.

PRACTICAL APPLICATIONS

The type of database determines, to a large extent, what kind of indexing method is most appropriate. The following sections discuss real-world CD-ROM applications and the factors that influence data retrieval.

CD-ROM directories. The developer must first determine the audience for a CD-ROM directory, because this type of database has two primary uses: an inquiry to find a single listing or to prepare a list of entries. Each represents a different combination of requirements for the retrieval system.

Inquiry is directly analogous to telephone-operator assistance. The user has a particular listing in mind and is interested in finding only that one piece of information. For this application, it is better to devote more RAM to the index and reduce the storage devoted to data. Reducing the number of search terms to the name only may be possible. With this limitation, the data record can be combined with the index for even better performance.

Despite the simplicity of the overall database structure, real-world problems complicate the indexing scheme. The names in a directory are actually formed from several separate fields. The surname should be located on the left, for easy alphabetical browsing, followed by given names or initials. Even

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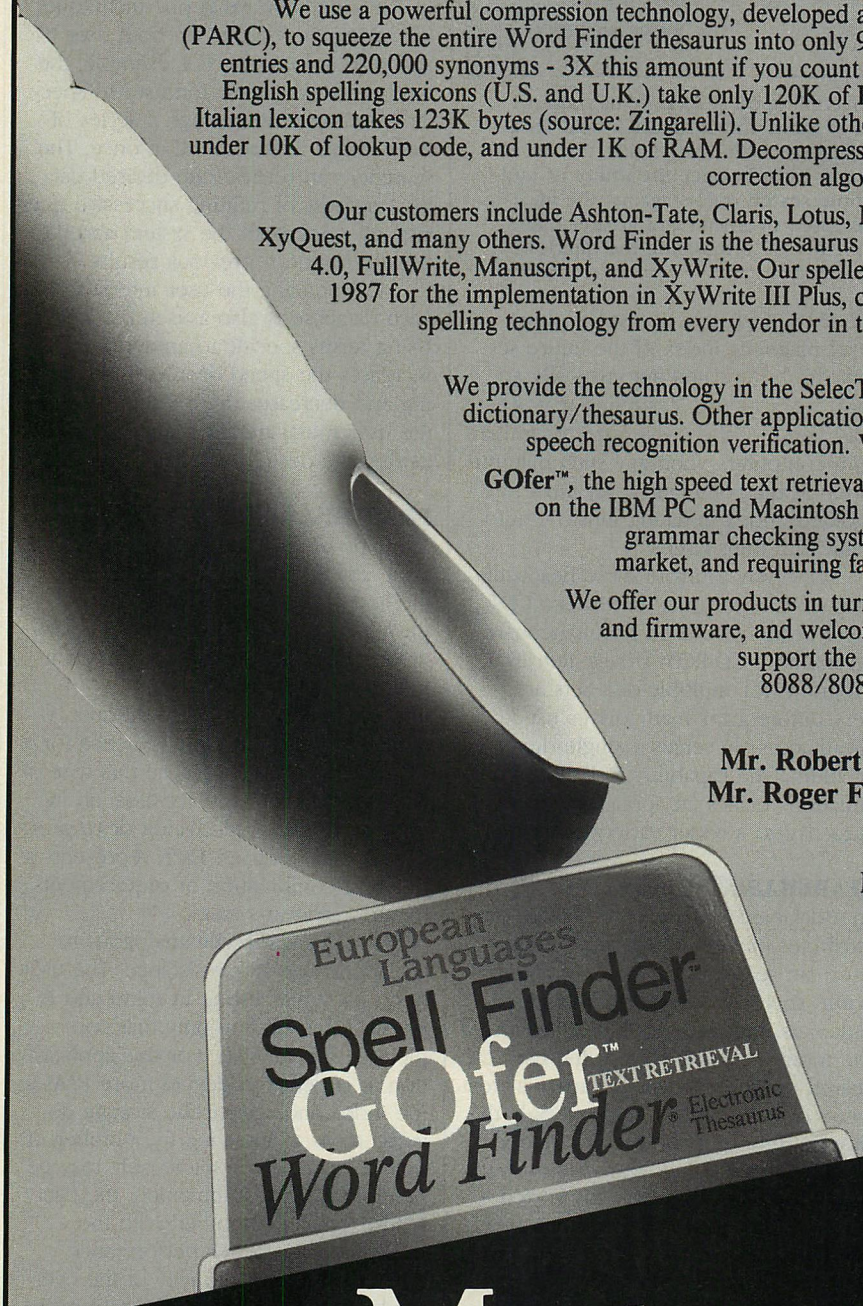
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indexing all given names with correct surnames can be challenging because the searcher will often use a surname and a second given name as a single search term. Further, some directories contain the individual's name followed by the title and occupation, while others list the occupation before the name. As a result, no single rule applies for indexing directories.

When the primary name in the directory is a company rather than an individual, no initials or title fields are present. Names that begin with numbers require special indexing rules. Alphabetical characters can easily be sorted. Alphabetizing a company name beginning with a number, such as the 3M Company, which should be listed under the letter T, requires an extra step because numbers precede letters in the ASCII collating sequence.

It is often appropriate to search a directory by street address. Here, the house number and street name should be placed in separate fields. Then, searching the neighborhood becomes a feature of the CD-ROM directory. Other fields that should be considered for indexing include direction and thoroughfare designation.

Internal or corporate directories. A corporate directory can be much more than a listing of employees. In addition to employee names and telephone numbers, it also could contain branch-office locations, hours of operation, and facilities.

The actual directory data (such as employee names and telephone numbers) may be organized as fixed-length fielded records; other types of data in the directory, such as financial reports and operating-procedure manuals, require a full-text index. To make the situation even more complex, corporate memos and procedural changes can be added to the database, possibly requiring production of a new disk every week. Each enhancement to the utility of the database makes additional demands upon the retrieval system.

If the corporate-directory disk is to become a truly useful resource, it should grow as the company grows and its needs change. A picture of each new employee along with title, location, and telephone certainly is valuable. An image of every company form stored on CD-ROM for use in a print-on-demand operation eliminates costly inventories. Software that allows employees to complete these forms electronically and send them through E-mail is a useful option on corporate CD-ROM publications.

Bibliographies and library catalogs. Already, CD-ROM is used in many libraries for bibliographic searching. This type of database is large, already in electronic form in many cases, and organized for retrieval. The library community agreed on a standard for machine-readable catalogs (MARC) 20 years ago. Developed by the Library of Congress, the MARC format contains a structure to deal with the variable format that typifies the bibliographic database. Each field in the database is predefined with a numeric tag by the Library of Congress. A record contains a collection of these tags, preceded by an index. The index within the record shows what tags are present in the record and where to find them. Some implementations follow the standard exactly, while many local variations have been developed.

In most cases, approaches that optimize retrieval from a magnetic database are not efficient in the CD-ROM environment.

To store MARC records on CD-ROM requires software that can read and make sense of the tag format. Typical MARC databases contain millions of records. A careful analysis may well reveal redundant records that can be removed. By combining the holdings of several libraries into a common MARC record (with suitable identification of the local holdings), duplicated fields are eliminated. This can reduce the number of disks needed to contain the complete database.

To index a MARC database, the developer must select the searchable fields from the tags available. Software packages with modest index overhead can index every tag, while other systems carry too much overhead for this approach to be viable. Certain fields belong together naturally. Grouping several author fields—such as primary and contributing author—for primary searching gives the user a good high-level search. If space permits, it is a good idea to provide individual tag searches as well.

The author field is an example of entire-field indexing. The author's full name, rather than the surname and given name separately, should be indexed, treating the entire field as a token for searching purposes. If the names are not recorded with surname followed by given names, title, etc., then the retrieval system should be programmed to flip the names. Ernest Hemingway, for example, must appear in the H section, not the E section. Subfields can appear multiple times for MARC records; therefore, the index should recognize these multiple occurrences in the index.

CD-ROM catalogs are available to the general public in a number of libraries. The states of Maine, Pennsylvania, Virginia, and Wisconsin are implementing state-wide CD-ROM public-access catalog programs. These public catalogs are indexed on three search fields: title, author, and subject.

The American Library Association has devised a standard convention for treatment of leading articles (a, an, the). By indexing the full title, the entire phrase is searched as one token. It is a good idea to combine all types of titles (books, periodicals, films, records, and videotapes) because the typical public-library user will not want to distinguish among the various media types when performing the search. The developer should index the media-type field, however, because more sophisticated users may want to specify media type in combination with title.

Technical reference manuals. A hierarchy of manual numbers works well for the top-level search of a technical-manual database. Most technical documentation is already well-structured for indexing. A technical manual about automobiles, for example, might be organized by year, model, and body style.

A full-text search of the descriptive-information field in a technical manual forms a powerful new access point. If the documentation has been developed or updated recently, it may use a standardized nomenclature. In certain data managers, these standard terms are already maintained in a table, which is a good starting point for building an index. Otherwise, full-text indexing of all words in the description will suffice. The user can search the description field for individual words or phrases.

Graphics are an important part of most technical manuals. Line drawings may be available in electronic form and can be included in a CD-ROM manual. It is more efficient from the standpoint of both storage space and retrieval speed to cross-reference graphics rather than index them separately.

Good News!

While . . .

IBM remains resolute

IBM says it is in the OS/2 Extended Edition game for the long haul and that the product will evolve in several ways over time.

- **By mid-1989**, it will be a full data base server under OS/2. And through an upgrade called Enhanced Communications Facility, it will act as a gateway to IBM's DB2 on the mainframe and the data on the System/36 and 38 family.
- **By late 1989** or early 1990, the query manager will take full advantage of the OS/2 Presentation Manager interface.
- **By 1990**, Extended Edition and host data bases will communicate, allowing DB2 to extract data from Extended Edition. Transaction management will be handled by the data base queried, to ensure data integrity
- **After 1990**, multisite joins and two-phase commits for data security will become available. Also planned is the ability to have individual data base tables fragmented and located on different machines.

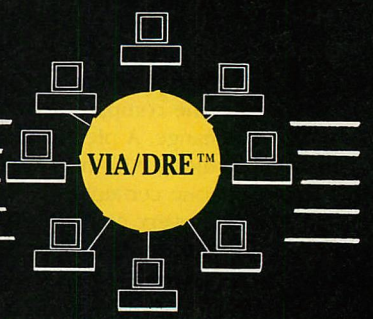
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Scientific databases. In applications with large quantities of numeric data, such as scientific fields, the searching procedure may be very different. This type of database often contains large matrices of numbers. Searching then becomes a process of matching data elements, such as data on an unknown substance to a CD-ROM database of known characteristics of substances. Numeric databases usually can be compressed significantly.

Scientific databases are often indexed prior to preparation for CD-ROM publication, and the indexes are heavily numeric. Because of their compactness, numeric indexes lend themselves to retrieval by B-tree structures; when keys are short, each leaf of the tree can reference many records, resulting in relatively few levels in the structure. However, many numeric databases must also be able to search for approximations and this requires different retrieval algorithms from the standard algorithms used for finding exact matches.

Scientific names tend to be long and complex, and the components of these names are often significant. By parsing the names into relevant components, and using full-text indexing on these name fragments, it is possible to create new search tools.

Publisher's manuscripts. Any major publisher deals with a large database of readily available electronic data, particularly the manuscripts that are ready for archiving. Maintaining copies of manuscripts on CD-ROM at various stages of development with all the markup tags has another advantage. Reprints can be produced from any copy of the CD-ROM, or downloaded to typesetting equipment. Searching on tags or structures of the database, such as titles, authors, subheadings, or foreign words, provides a new way to locate information in an otherwise unstructured database.

SEARCH FOR TOMORROW

Although the concept of building and retrieving information from a database is similar for both magnetic and optical media, the actual practice is quite different. In most cases, approaches that optimize retrieval from a magnetic database are not efficient for CD-ROMs. Database producers who do not adapt to the retrieval techniques optimized for CD-ROM will lose considerable performance and possibly users.

The retrieval times are abysmal for databases ported straight from magnetic media to CD-ROM. The slow CD-ROM access rate is not the only culprit—some database developers have not understood the differences between the two media nor implemented the necessary changes.

Even after understanding these differences and with sufficient time to climb the learning curve, users still must face other significant issues when considering methods of retrieving data from a CD-ROM system. Almost all of these issues stem from one central theme: CD-ROM is a microcomputer peripheral and therefore enters an environment that already includes other requirements, expected results, known processes, and a long, long list of individual-user idiosyncrasies.

Database producers who do not adapt to the retrieval techniques optimized for CD-ROM will lose performance and possibly users.

Because CD-ROM's most significant benefit is a means of distributing large quantities of data economically to large numbers of end users with microcomputers, it is impossible even to consider any kind of personalized, hands-on user training. Training is too expensive and time-consuming for both the producer and the user, and furthermore, it is contrary to the basic concept of a standard, down-to-earth, easy-to-use data distribution medium. However, an understanding of how to use a CD-ROM retrieval system is still necessary, and can be built directly into the CD-ROM product and be available for use as needed.

Many lessons learned with interactive video-disk training techniques—such as the use of color, graphics, and audio—have provided useful techniques for incorporating user information into the retrieval program and user interface. Certainly, this combination of data with built-in training is quite different from user interfaces typically found in magnetic storage and retrieval environments.

The pitfalls and problems to consider before producing a CD-ROM database are just as complex and include just as many considerations as for any other computer application. Certainly the creation of a CD-ROM database is compounded by a whole new set of indexing and retrieval methodologies. The process is further confounded by the fact that many types of users with different computer capabilities and assorted professional references all will be using the same CD-ROM retrieval mechanism.

Determining retrieval methodologies for CD-ROM can be a challenge, but it is not impossible—more than 300 commercially available CD-ROM titles prove this.

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Desktop Debates 2.0

Systems professionals look for ways to control the increasing power on the desktop. The problems are tough; the solutions are even tougher.

SUSAN HOLLY

If systems developers and end users are looking for simple solutions to their problems, they will have to keep looking. The PC world is not getting simpler anytime soon. The answers today are as difficult as the problems.

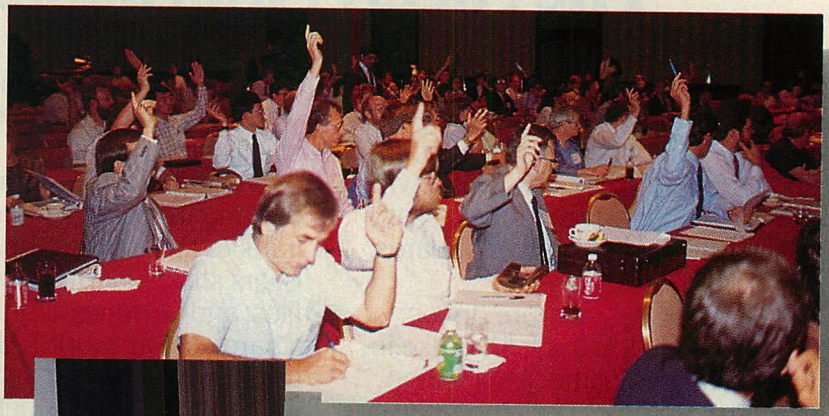
This message came through at *PC Tech Journal*'s Systems Forum '88 (June 12–15) with the same jolting reality of the earthquake (5.2 on the Richter scale) that jarred participants on the eve of the conference in San Francisco.

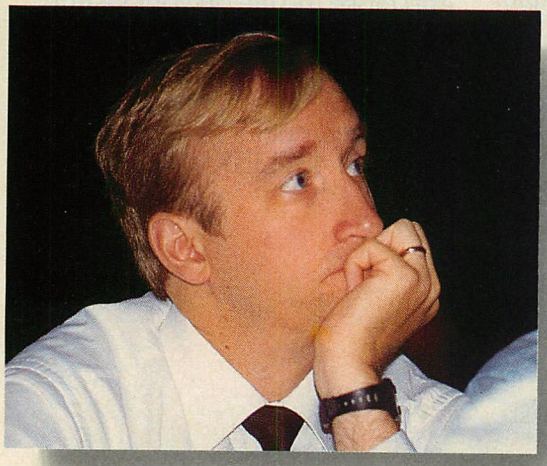
In this second annual Systems Forum, *PC Tech Journal* presented the topics that continue to glow red-hot for systems professionals: OS/2, heterogeneous hardware, end-user and user-interface concerns, Structured Query Language (SQL), and networks. Everyone is hungry for answers, for easy solutions, but as the conference came to a close, it was clear that the answers are not all that easy. Participants did discover, however, that they are not alone in being overwhelmed by the growing power and complexity at the desktop. Nearly everyone is perplexed.

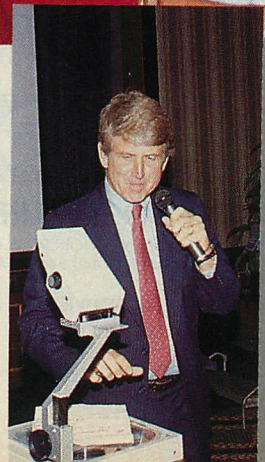
Desktop choices used to be simple. You decided on IBM and proceeded from there. Now, systems professionals are faced with developing for at least four different platforms—DOS, OS/2, UNIX, and Macintosh. They must deal with varying buses even within the IBM-compatible world, networks of machines from different vendors with different philosophies, networks of those networks, diverse and vast distributed databases, confused end users, and either a lack of or too many standards for just about everything.

Not only are hardware and software options so plentiful that systems professionals' technical skills must be finely honed to make the best choices for their companies, but also management skills have taken on new importance. Knowing ASCII tables backward and forward is not enough

PHOTOGRAPHY • DAVE BUSH







Systems developers and integrators gathered in San Francisco for three days in June to discuss the growing complexity of desktop computers. *Clockwise from left:* Mike Purcell, staff software engineer for Baxter Health Care, focuses his attention on a panel. • The audience participates. • 3Com Chairman Robert Metcalfe talks about networking networks.



PC TECH JOURNAL

Systems Forum '88

SAN FRANCISCO





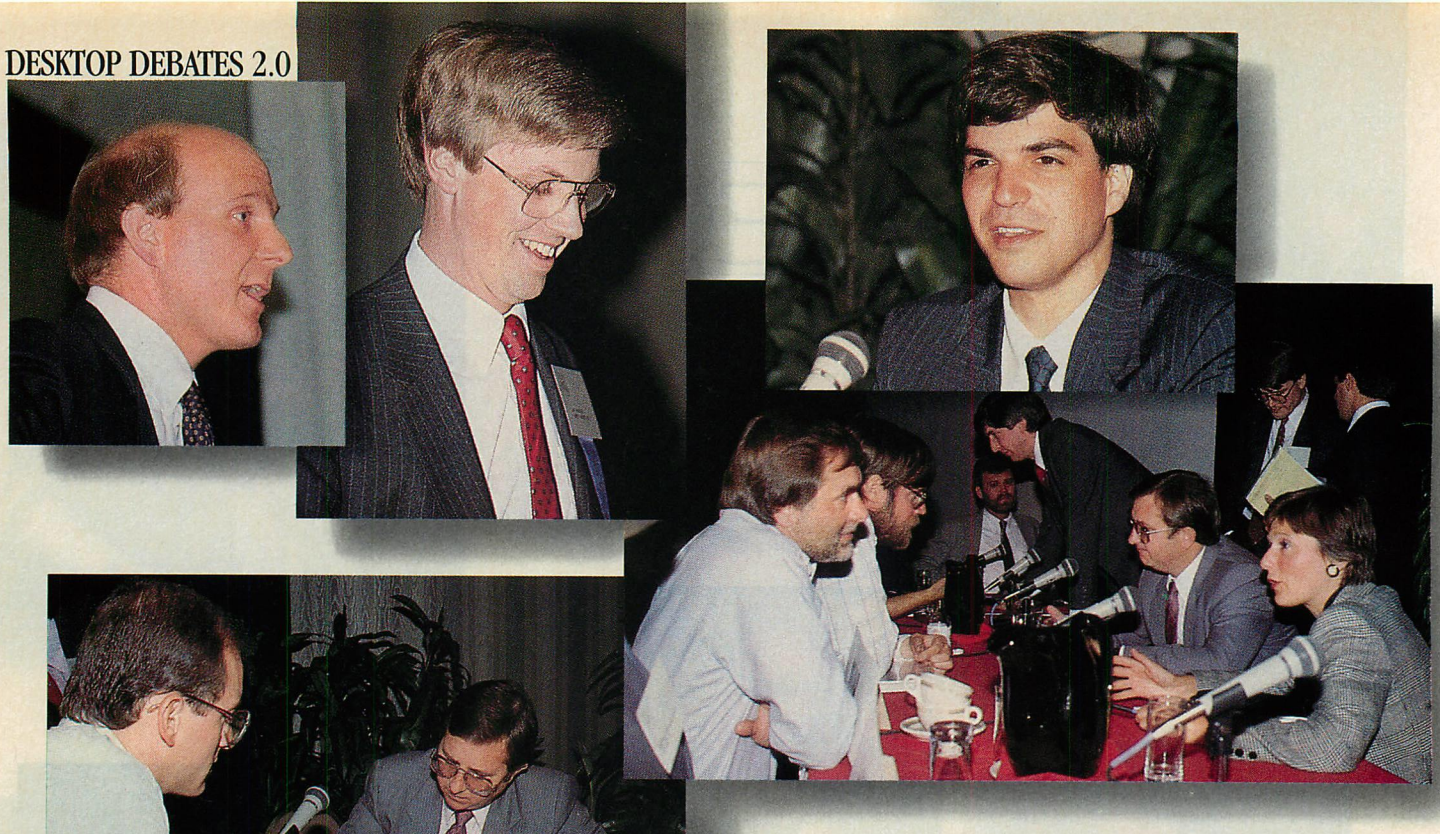








Clockwise from top left: Systems Forum moderator and *PC Tech Journal*'s editorial director, Will Fastie, talks to Hardware Melting Pot panelists Peter Watkins, applications marketing manager for Apple; Thomas O'Leary, director of MIS for North American Philips; and Chuck Peddle, president and CEO of Tandon. • LAN Systems President Tyrone Pike (left) confers with Peter Coffee of The Aerospace Corp. • IBM's Thomas Peters responds to a question as Tom Simondi of The Aerospace Corp. listens. • Doug Allen, senior systems analyst for Franklin Research, makes a point from the audience. • Participants fill the meeting room at the St. Francis Hotel. • Wylie Crawford of Kenwood Associates (left) and Harry Saal of Network General compare notes. • Banyan's cofounder Anand Jagannathan sits on the Networking Networks panel.



Clockwise from left: Microsoft's Steve Ballmer delivers a luncheon speech extolling the GUI. • Gary Gunnerson, IC manager for Gannett, talks about his experience networking networks. • AI Architects' Greg Papadopoulos did not hesitate to blast Intel during the 386 Platform panel. • Post-panel discussions hold the attention of Peter Coffee (leaning over), WordPerfect's Pete Peterson, and Leslie Fiering from Banker's Trust. • Peterson takes down suggestions from Steve Patzer of Intel.

anymore. "The boss is taking a hard look at the bottom line and is amazed at how much he has spent over the past years," said keynote speaker James Nestor, senior manager, microcomputer R&D, for the Big Eight accounting firm of Ernst and Whinney. "The look on his face is different now when you tell him to spend millions on new technology and write off the old."

Participants agreed that their jobs have more than one side. As Peter C. Coffee, engineering specialist for The Aerospace Corporation and managing partner of SolveWare, commented, "PC support can't simply be technical experts anymore. We've got to understand the business. Do you know what your company does for a living?"

Indeed, systems professionals are faced with a difficult job that requires more technical expertise than ever about a wider range of topics. This expertise, reinforced by business finesse, is necessary in order to explain to the executive suite how the new technology can be cost effective.

The new technology means OS/2 and new user interfaces; it means 386 chips and changing bus architectures; it means SQL servers and distributed processing; and, perhaps most difficult of all, it means networks. Conference speakers and attendees faced each of these challenges head on.

INEVITABLE OS/2

The conference began with a topic very much on people's minds today: OS/2. What the panel revealed, however, was that little, if any, controversy remains about the new IBM/Microsoft operating system; OS/2 is now a fact of life that people have accepted—or at least resigned themselves to. They did, however, voice definite concerns about *converting* to OS/2.

IBM representative Tom Peters, manager of software developer support/contracts, told the audience that "*now* is the time for people to begin to use OS/2." According to Peters, IBM envisions two roles for OS/2: (1) for developing new applications that take advantage of the built-in Presentation Manager, data manager, and communications manager, and (2) for improved DOS applications. Peters pointed out that the list of OS/2 applications represents many different types of companies, just as has been the case with DOS. IBM's goal is to have 1,000 OS/2 applications by the end of the year, although many of these merely will be warmed-over DOS applications.

WordPerfect Corporation's Executive Vice President Pete Peterson admitted to being a born-again OS/2 convert. "I was an OS/2 basher for awhile. I was hoping to see a 386 operating system." Although WordPerfect was, and still is, very successful in the DOS environment, Peterson now sees OS/2 as the best solution for three reasons: it addresses the major problems WordPerfect had in developing under DOS, it has the support of software manufacturers, and it is IBM's choice.

Other panel speakers voiced acceptance of OS/2. Martin Herbach, vice president of development for Computer Associates, said he supports OS/2 despite the cost involved in training and in upgrading hardware. He predicts that OS/2 will open up new kinds of software for a new user base. "The spreadsheet we use now will look very obsolete in a couple of years when we start blending capabilities from mainframe software, such as modeling lan-

guages that will enable us to add an optional discipline on top of our unaudited spreadsheets." he said.

Tom Hoffmann, manager of systems development for ROADNET, an affiliate of United Parcel Service, already is developing in-house applications on OS/2. He said the OS/2 environment suits his purposes because it has multitasking, handles large programs, works on Novell networks, and is more standard—and has a lower conversion cost—than UNIX. "Who needs OS/2?" he asked. "I think we all do."

Other OS/2 panelists took more cautious stances than did Hoffmann. Tom Simondi, manager of microcomputer planning and integration for The Aerospace Corporation, complained that OS/2 does not run on his broadband Novell network. He further complained that because OS/2 is 286-based, it is limited in what it can do, it requires lots of RAM, needs a large and fast hard disk, and does not run every piece of DOS software.

David Hasiba, manager of micro acquisition/maintenance support for Merrill Lynch, is taking a cautious look and especially is concerned about the high cost of using OS/2, which he believes will go even higher as the price of memory chips continues to climb.

WordPerfect's Peterson said despite his better-late-than-never acceptance of OS/2, he is not without complaints. For example, "Why on earth are we still dealing with 11-character file names?"

Questions from the audience indicated that they, too, see OS/2 as inevitable, but they have concerns, about which they drilled IBM's Peters. Intel's Senior Software Engineer Steve Patzer said, "We're going to be forced to live with an OS based on a 4-year-old technology, the 286. It's a cruel joke played on the 386 people." Peters responded that IBM had surveyed a number of its large customers and found that most had a large base of 286 machines. Further, he said, applications developers encouraged IBM to focus on the 286.

Ken Brooks, advisory systems engineer for the Bank of America, one of IBM's large customer accounts, retorted, "I personally resent getting the blame for an 80286-based OS/2. Your customers tend to have to foot the bill for your R&D plans."

Another complaint that surfaced was the matter of support. "A real operating system needs a real support policy," said Thomas O'Leary, director of MIS technology for North American Philips (NAP). IBM now warrants OS/2, but only for 90 days after purchase.



Clockwise from top left: **Ashton-Tate's Roy Folk heeds his own advice to listen to end users. • Richard Schwartz, vice president of database technology for Borland, listens to audience questions. • The well-received session on SQL included Umang Gupta of Gupta Technologies and Herb Edelstein of Euclid Associates.**

Peters pointed out that IBM has moved from providing no support for DOS to the current level of support for OS/2.

Concerns aside, many participants acknowledged they eventually would move to OS/2, although few had as yet. As WordPerfect's Peterson summed up, "OS/2 bashing is not really relevant anymore. The real questions are, 'When does your company start using OS/2, and who is going to use it?' "

ABSOLUTELY GRAPHICS

Part and parcel of OS/2 is the graphics user interface (GUI), Presentation Manager. Responses to the question, "Why a GUI?" elicited strong support among panelists. "Simply, a picture's worth a thousand words," said Gordon Sollars, vice president of distributed systems for Merrill Lynch. "The GUI is here; I don't believe we can ever go backwards," said Peter Miller, president of ON Technology.

Predictably, Microsoft's vice president of systems marketing, Steve Ballmer, as enthusiastic a proponent of the graphics user interface as there ever was, answered the "Why GUI" question simply and directly, "Why? It's absolutely why not!" Ballmer started off an afternoon of GUI discussion with a rousing endorsement of Presentation Manager, which, he said, means standardization, richness of expression, reduced learning time on each additional application, "annual-report quality" of output, and device independence.

While Ballmer sees a long future for DOS, "at the same time we [Microsoft] are doing everything we can to cajole, encourage, support, and move applications developers forward to do their next-generation great ideas on top of Windows and Presentation Manager." He predicted that applications using features of Presentation Manager will start to appear in early 1989.

In response to a question from Mike Purcell, staff software engineer for Baxter Health Care, who accused Microsoft Windows of running "disconcertingly slow" on a 16-MHz 386, Ballmer indicated that Microsoft is continuing to work on the problem. "There's a lot we can do to speed things up—strictly algorithmically."

Apple's lawsuit against Microsoft for infringing on the "look and feel" of the Macintosh interface generated sev-

eral questions throughout the Systems Forum. In response to the question, "What happens if Apple wins the case?" IBM's Peters simply said, "I don't think it's a real possibility." Ballmer said, "If Apple wins, they'll win on certain elements of the visual interface. [Only] those specific elements that were deemed infringing would need to be changed—it might be as simple as rounded borders can't be rounded." Others, including Chuck Peddle, president and CEO of Tandon, hope that a loss by Apple would promote the cause of a standard interface across vendors.

In Apple's defense, Peter Watkins, the company's applications marketing manager, likened the case to a dictionary. "You can't copyright words in a dictionary, but when a poet puts them together, it's different."

Some developers expressed concern about developing applications for the graphics user environment. Peter Winer, vice president of product development for the Living Videotext division of Symantec, said, "Most benefits accrue to the user, and, for the most part, the larger costs are borne by the developer. You've got to write bigger, more complicated code."

"The first is the worst," said Micrografx President George Grayson, because it requires a different mindset and different tools and facilities developers are not used to." Miller agreed that developing for the GUI is "one or two orders of magnitude more difficult than for a character-based interface.

Some people warned against losing sight of the user's needs and which interface—character or graphics—serves those needs better. Greg Papadopoulos, executive vice president of AI Architects, called this tendency "the talking-toaster syndrome," in which developers get carried away with how "neat" the interface looks. Sollars agreed, "Gee-whiz stuff for its own sake isn't going to get any acceptance from the user" and generally works itself out through natural selection. Richard Schwartz, cocreator of Paradox and vice president of database technology for Borland, added, "You can dialog-box people to death. The challenge of the environment is to try to find the right way to use it."

Gary Loewenthal, a consultant with Information Analysis Inc., contended that "it's possible to get 75 percent of the benefits of a GUI application just by carefully designing the front end of a character-based system—a good menu, intuitive." But, Sollars quickly added, "We're here to do things that couldn't be done with a character-based interface."

"Will Presentation Manager be sufficient reason to go to OS/2?" asked Leslie Fiering, assistant vice president of advanced technology for Banker's Trust. Winer responded, "You'll move [to OS/2] the day somebody comes out with a very appealing improvement on something you're doing with DOS."

386 PEP RALLY

Questions of why or when to move to new hardware technology were echoed in the panel, "Toward the 386 Platform." Few people would turn down a 386 if it were handed to them—everyone loves its power and speed. Obviously, cost is the limiting factor.

"Our big problem is price. We have to restrict ourselves to [putting 386s] in areas that show a big return—such as the development community," Fiering said.

Some developers expressed their concern about the difficulty of developing applications for the graphics user environment.

Therese Myers, president of Quarterdeck, said the 386 provides certain benefits for about a $1,600 premium over the cost of a 286, "but it still just gives you what your people can use." Perry Davis, vice president of information resources for the advertising agency of Saatchi and Saatchi, admitted to having a "love affair with the 386," because the processor had made a big difference in administration at his agency. ROADNET's Hoffmann said that all the software developers at his company have 386s. "In our case, it was very simple: faster is better," he explained. The 386 allows them to use DOS extenders, UNIX, or OS/2, Hoffmann said, adding that he especially likes the built-in hardware debugging feature on the 386.

Fiering called herself "another 386 yea-sayer—if nothing else, it's a great DOS machine." She, along with others, hopes to see new applications for the 386 that wouldn't be possible otherwise, but no vendors present at the Forum were forthcoming with plans along those lines.

The other side of the 386 issue is what to do with the existing base of 80286 and 8088/86 machines. "Management doesn't want to hear that the $20 million invested in old equipment is being thrown out," Fiering said, adding she has had very little luck finding a good 386 add-in board for the AT. James Perry, senior systems consultant of ARAMCO, said he uses the trickle-down theory. Older machines move down to the low-end users, and ARAMCO is still buying PS/2 Model 30s as well. "The 8088 boxes will be around for awhile," he said.

James Johnson, general comanager at Intel, responded that Intel realizes the 386 cannot dominate the market at current price levels. He said the 286 will continue to meet a lot of needs, and, he added, the direction Intel is moving now for the non-power user is the 16-bit 386SX chip.

Even as Systems Forum participants described their difficulty in finding homes for the older machines and budget approval for the 386, Johnson started talking of the 486 and 586. "But," he said, "going from the 386 to the 486 to the 586 will involve slight modifications rather than fundamental changes." Is that any solace to the company full of PCs, XTs, and ATs?

MAC ENVY

Complicating matters further is the existence of the hardware melting pot, which mixes not only different processor speeds, but also different philosophies. A big question at the Systems Forum was "What about the Mac II?" While Intel's Johnson drew a laugh when, looking perplexed, he replied, "I'm not familiar with that product," the Macintosh was very much on the minds of participants.

About half the audience said they had both PCs and Macs, but, for the most part, PCs are the major system, with Macs performing isolated functions on the periphery.

"The M-word," NAP's O'Leary called the Macintosh, and he asked rhetorically, "How do you deal with Mac envy?" O'Leary argued that, as professionals, "we should learn to use both [IBM and Apple products]." Macs account for 10 percent of NAP's computer base. The problem so far is that "Apple can't seem to provide support in a mixed environment," O'Leary said.

Alex Kask, senior manager of Ernst and Whinney, said that accounting firm has 8,000 computers, 20 to 25 different models, and has no problems with this mixture—but only because each serves



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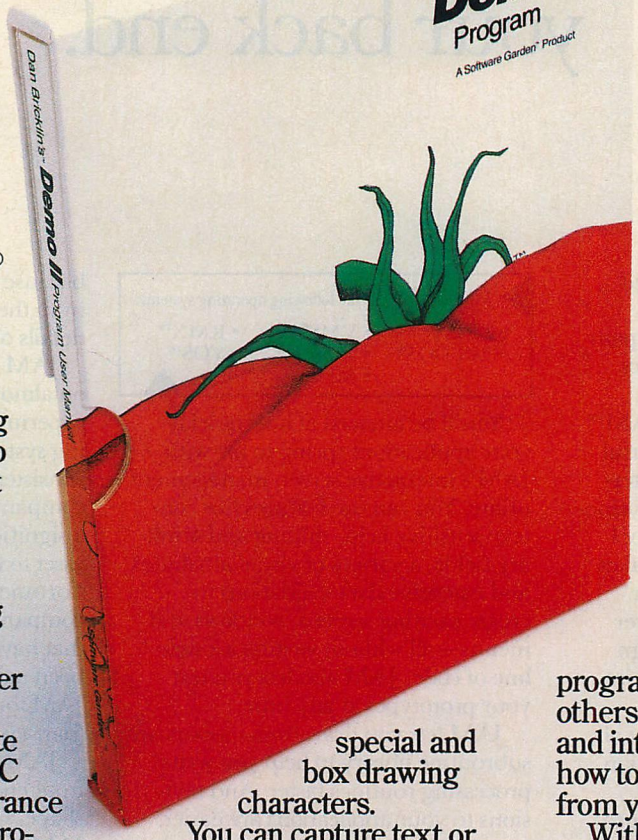
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a specific purpose and few are connected. "We are closer to apartheid than to a melting pot," he said.

Dennis Quinn, manager of data processing for the Phoenix Group, pleaded for vendors to move faster in the direction of AppleTalk for Novell and Ethernet. He also mentioned TOPS, which he said is available now but has problems with speed and data security. Bruce Laufer, LAN coordinator for the law firm of Wilmer, Cutler, and Pickering, said he believes software to be the solution to his mixed environment of 500 machines from 10 different vendors. "I'll buy the first network operating system that allows me to network all these together."

BATTLE OF THE BUS

A heterogeneous vendor environment means different buses, and the ongoing bus battle continued on the floor of the Systems Forum. Compaq's Gary Stimac, vice president of systems engineering, gave his company's view from the front line, saying that Compaq's dual-bus architecture gets maximum performance from CPU, disk, and video subsystems, whereas IBM's Micro Channel does not optimize its subsystems.

"Compaq is driven by customer needs," Stimac said. "We have not seen the demand [for the Micro Channel]. We would be driven to the Micro Channel if we saw some performance advantages. We do not see them."

Similarly, Safi Qureshey, president of another 386 competitor, AST Research, said, "If and when the market is ready for the Micro Channel, we will come out with an improved product, not just a clone."

On the other hand, Cumulus President Marty Alpert believed strongly enough in the Micro Channel to found his own company in order to manufacture PS/2 peripherals. "Micro Channel wins because it's better. How big it wins is because of IBM," he said.

Many agreed that the availability of peripherals will be key to the Micro Channel's success, but participants wondered where those peripherals are. "It's been 14 months, and I would like to see some of those coprocessors," Qureshey said. Brian Livingston, assistant manager of information systems for the Union Bank of Switzerland, predicted that the Micro Channel would generate fewer boards than the classic AT bus because Micro Channel boards are smaller and require a difficult manufacturing process.

Diane Danielle, assistant vice president, finance LAN, for Wells Fargo Bank, expressed her view of the bus wars this way: "Until I see an application that runs better on the Micro Channel than on the classic bus, I see no reason to change."

For Danielle and other end users, the specific type of bus inside the machine is not as important as whether or not it is a good, reliable computer that performs its various tasks well. Thomas O'Leary drew applause when he said, "Who cares if it has Micro Channel or not if it's a good computer."

SQL SEQUEL

Whereas systems manufacturers have yet to fight the bus wars to a conclusion, data-management vendors have been able to agree on at least one important issue: SQL is the language of choice for distributed processing. This hardly means that all problems are solved, however.

Most of the SQL panelists agreed—albeit somewhat reluctantly—that IBM will figure heavily in the SQL market for PCs.

Umang Gupta, president of Gupta Technologies, which develops and markets distributed SQL software, listed the advantages of distributed (or as he called it, "cooperative") processing: it partially offloads minis and mainframes, permits the use of graphics development tools, takes advantage of GUIs, integrates PCs into corporate networks, and, in five to seven years, will replace dumb terminals.

"SQL is a big move to standardization, but not all SQLs are the same," claimed Herb Edelstein, a partner with Euclid Associates, which specializes in data-management consulting. Edelstein complained that the exact same SQL statement may work differently in different systems. "SQL doesn't make my job as a database designer any easier," he added.

What is lacking, according to Edelstein and other SQL panelists, is a standard application program interface (API). Doug Woodward, vice president of engineering at Novell, said, "With a standard API, all front-end applications could run transparently with any back-end engine, which would give users the ability to select products from different vendors." He told the users present, "The only way to get there is for you to demand that vendors support some kind of standard API."

Dave Browning, cofounder and president of WBS and Associates, a data-management consulting firm, said he cannot sell his clients a one-company solution, yet that is the flaw in many SQL implementations. Browning blamed the situation on SQL migrating down from mainframes, bringing with it the mainframe mentality of a one-vendor solution.

Which vendors will be the big hitters in the SQL market for PCs in the next year? Most panelists agreed—albeit reluctantly—that IBM will figure heavily. "This is interesting because it doesn't have a product out yet," Richard Finkelstein pointed out. (OS/2 Extended Edition 1.0 with the data manager was released at the end of July.) Finkelstein, president of Performance Computing, which specializes in SQL database development, also predicted that IBM will share the market somewhat evenly with Microsoft and Lotus, both of which are developing SQL database servers. On the second tier, he expects Novell and XDB Systems to compete head to head, but he left a big question mark next to Ashton-Tate, which (despite strategic alliances with Microsoft and InterBase), has yet to show its capabilities in the SQL arena.

Finkelstein further predicted that front-end development tools, such as SQL Windows from Gupta Technologies, will become prevalent, and, he said, we will see the emergence of a new class of products based on hypermedia that will integrate graphics, sound, and images.

Gupta conceded that IBM undoubtedly will continue to dominate the mainframe SQL market, "but on PCs, I'm not confident that's the case. There are likely to be four or five major players, with none dominating." These players include Lotus, Ashton-Tate, Oracle, Microsoft/Sybase, and IBM with its OS/2 Extended Edition.

No matter who the players are, Systems Forum panelists and attendees have realized that SQL and distributed processing are a boon for PCs. "People argue whether SQL is good or bad, but it doesn't matter," Edelstein said. In the mainframe or mini world, he argued, "if you don't offer SQL, you're out of business. The micro world is moving in that direction."

"You're going to need to know about SQL," Edelstein concluded.

You are also going to need to know about networks and all issues related to them. Networks commanded a full day at the Systems Forum. In sessions ranging from guidelines for managing networks to the low-level details of the API to the finer issues of networking networks, panelists and attendees voiced concerns about the finicky nature of LANs, proprietary hardware and software, incompatibility, and the challenge of making decisions now that will pay off (or at least not backfire) down the road.

About three-fourths of the audience indicated that they had LANs of at least 25 nodes. With network growth being so phenomenal, participants marveled that key issues resist resolution.

Networks are not single-vendor solutions. "I have yet to find a vendor or software company that does the whole job," said Gary Gunnerson, manager of the information center for Gannett. The burden is on the network manager to put all the pieces together.

This burden is made heavier by an industry so far unwilling to commit to standards. During the Forum, network vendors came under attack for being proprietary. "Developers don't want so many API choices," said Robert Shostak, codeveloper of Paradox and cofounder and executive vice president of Mira Technology. "Why can't vendors simply get together and decide on one? The answer is they feel they need to differentiate their products."

Novell's vice president of corporate marketing and development, Craig Burton, denied the charge. "We have our own APIs now because none existed before. We will integrate new APIs from other vendors if users want."

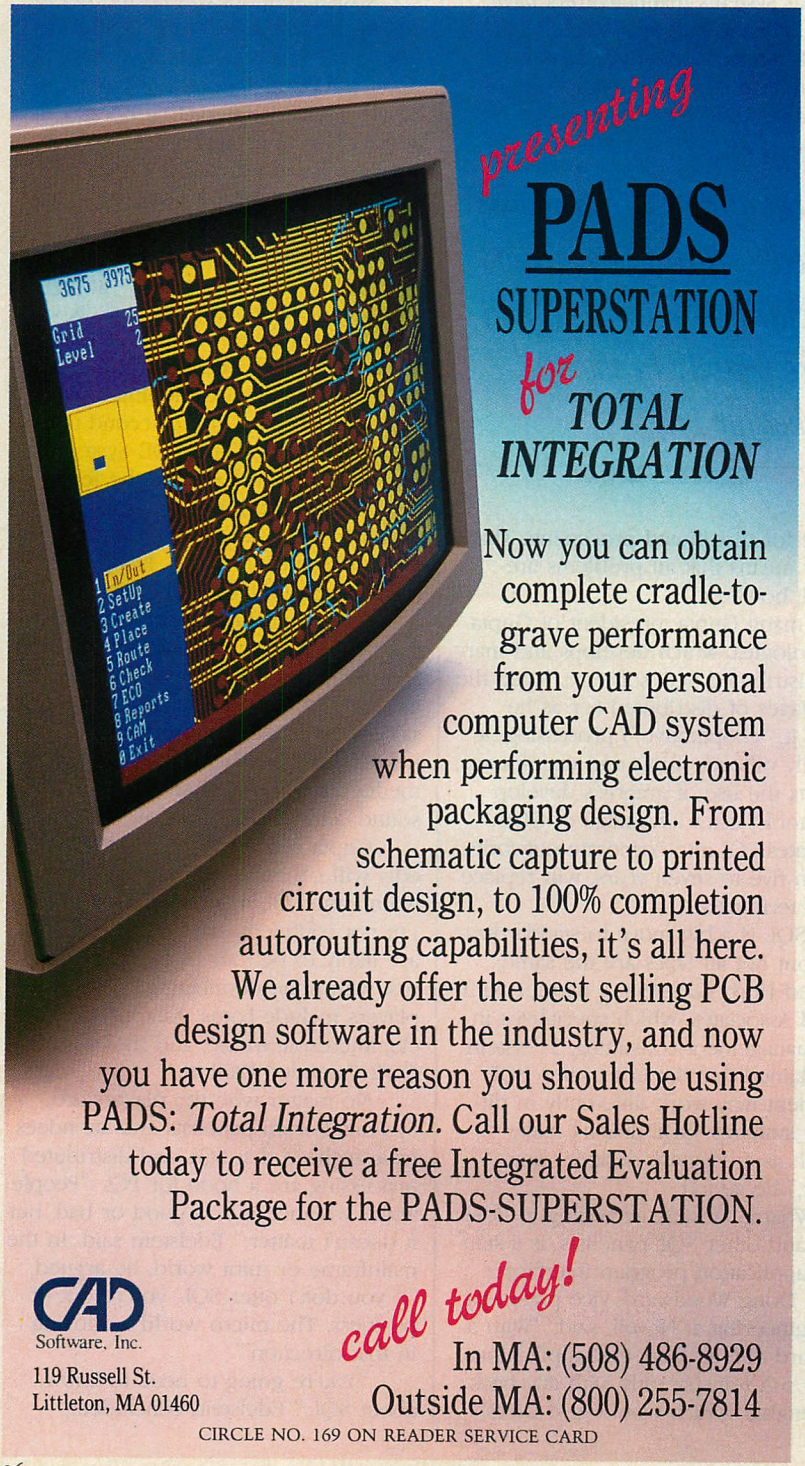
But panelists did not give up their attack. Mark Freund, vice president of Interconnect Network Consulting Group, called it a "real mistake" for Novell, 3Com, and Banyan to fight among themselves. If it continues, he said, "the overall winner will be IBM." But, again, Novell's Burton defended his company: "It is an illusion that our intent is to drive ourselves into a proprietary hole."

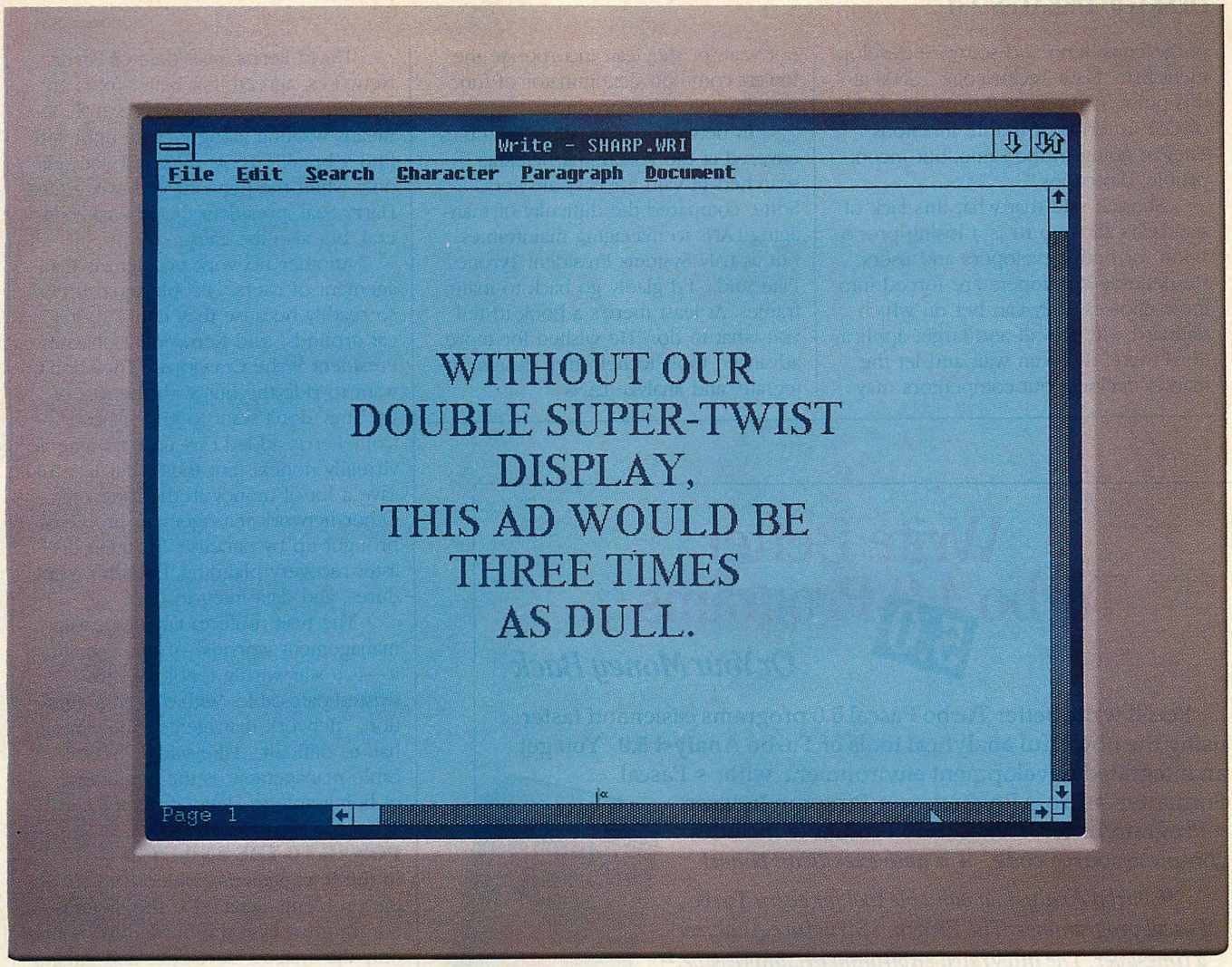
The only solution for users, according to Nestor Holynskyj, vice president of private banking for Morgan Guaranty, is to marry the vendor and run the risk of becoming proprietary or to marry one of the half-dozen integrators around the country who know how to set up a network.

When asked what standards will prevail, no panelist had the definitive answer. In the area of APIs, Mira's Shostak predicted that the winner would be whichever company has the best market share—Microsoft, Novell, 3Com, or IBM. Cheryl Currid, manager of departmental computing for Coca-Cola Foods, said that because corporations are not about to throw out what they already have, future standards will be based on what is here now. She thinks Novell has the lead in that respect. Finally, Andy DeMari, president and CEO of Retix, is certain that the Open Systems Interconnection (OSI) standard will predominate.

OSI also got the nod as a standard for networking networks. 3Com Chairman Robert Metcalfe called OSI and ISDN the wave of the future. However, Banyan's cofounder, Anand Jagannathan, disagreed. "If you are waiting for OSI to be the ultimate solution, you are going to keep waiting." He encouraged the entire industry to standardize on NETBIOS as an interface and devise a standard way of mapping names.

"IBM's Systems Network Architecture (SNA) is a viable alternative today," said Dennis Linnell, president





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of the consulting and software development firm, Gate Technology. "SNA, at this point, is three or four years ahead of OSI in terms of usable functions. They're going in the same, but incompatible, directions."

Shostak said that what this lack of standards adds up to is a losing proposition for both developers and users. He believes developers are forced into three choices: they can bet on which standard will prevail and target applications there; they can wait and let the market decide—but competitors may not wait; or they can incorporate the lowest common denominator of functionality into their products.

In networks, as in all other topics covered at the Forum, participants searched in vain for easy answers. Some compared the difficulty of managing LANs to managing mainframes, but as LAN Systems President Tyrone Pike said, "I'd gladly go back to mainframes. At least there's a book to tell you what to do." He wished for more advanced tools to help him design, integrate, and analyze LANs.

David Ferris, president of Ferris Networks, agreed that better tools are needed. "Average network control means walking along a cable until you find a break." Tools must tell you not only when the network is down, added Harry Saal, president of Network General, but also the cause.

Another network problem is management of users. "People took to PCs so readily because they could sports-car around," said Kenwood Associates President Wylie Crawford. "They don't want to ride the bus with the rest of us. They don't want to give up control." Ferris added that user training is virtually nonexistent today, but it would save a lot of money in the long run. Other network management problems brought up by panelists included disaster-recovery planning, backup procedures, and data integrity.

The best route to take for easing management worries—if you can afford it—is a star wiring topology with twisted-pair cable. With this configuration, "network management becomes half as difficult," Pike said. "Physical cable management is the beginning of being able to sleep at night."

POWER TO THE END USER

In the final analysis, solutions to all the problems debated at the Systems Forum must ease the burden for not only the systems developer and integrator, but also the end user, As Roy Folk, executive vice president of Ashton-Tate, said, "The only way any of us in the business can produce industry-leading products is by listening to the end user." Or, as Lotus Corporation's Senior Product Design Manager Scott Tucker put it, the end user always wants "more, faster, better."

WordPerfect's Pete Peterson advocated that software vendors back up and do the simpler tasks first, such as proper documentation and support. "We are overshooting the mark with technology."

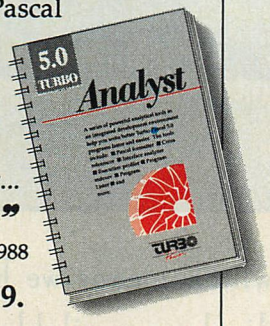
Indeed, this may have been the best advice of all during the three days of Systems Forum discussions. For those participants searching for solutions to the complex problems of the technologically complex PC world, focusing on the most basic, simple components may take you a long way toward a solution.

Susan Holly is executive editor of PC Tech Journal. *Senior editor Gail Shaffer contributed to this article. For information on next year's Systems Forum, circle 300 on the reader service card on page 175.*

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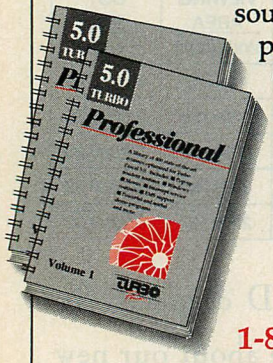
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A large part of the attraction of a personal computer comes from the fact that it is *personal*. You can get your arms around it and see all of its working parts for yourself. This gives you the feeling that the computer is working for you and you alone. One factor contributing to this feeling is that the computer is small enough to fit on top of your desk. You don't have to travel to some huge computer room to watch your data *not* being processed.

With a true desktop machine, you also can fiddle with switches and change add-in boards conveniently. On the other hand, if its large proportions banish the unit to a position under your desk or to some other corner of the office, you are likely to skin your knees, take your back out, or hit your head on the underside of the desk as you try to access it.

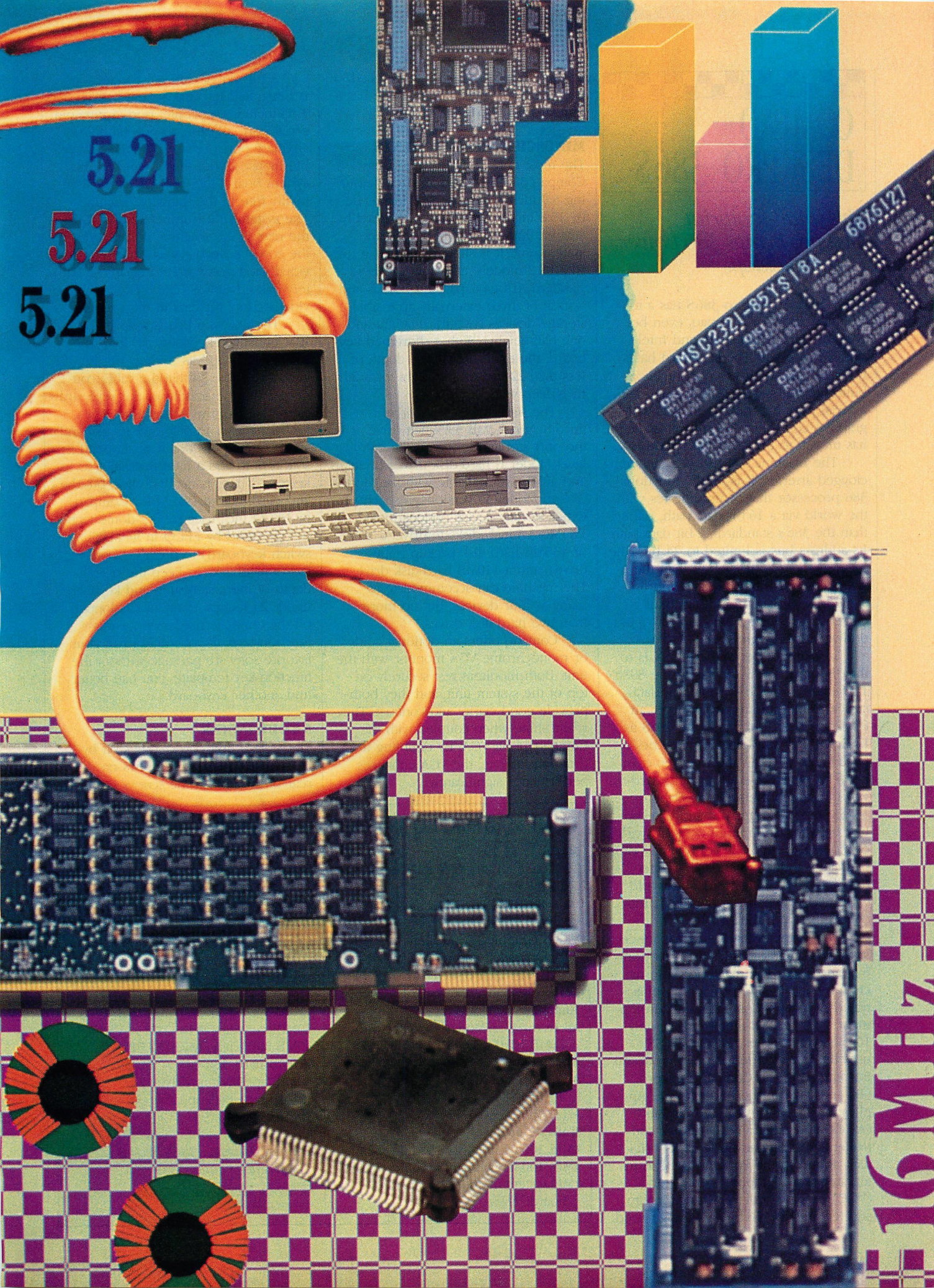
The popularity of desktop PCs also has come traditionally from the fact that they require minimum space in today's cramped office environments. The size of desktops has always been their strong suit when compared to minicomputers, and it is even more essential if PCs are to continue to invade the ranks of employees who don't have much more than a cubicle to call their own.

Unfortunately, as the PC has become more and more powerful, it has gotten much bigger. The IBM PC was bigger than the Apple II; the IBM PC/AT was bigger than the PC; and the IBM PS/2 Model 80 is so big that it falls off the desk and lands on its end. Hulking machines such as the ALR FlexCache 25386, although extremely powerful and having huge amounts of storage capacity, almost demand to be hidden in an out-of-the-way niche. The trend has been: if you want a more powerful personal computer, you have to buy a bigger, more expensive, and less personal one.

In June, however, Compaq and IBM introduced new PCs that reaffirm a commitment to providing top machine performance in a system that fits on top of your desk and is truly personal. Both machines reviewed in this article use 32-bit Intel processors: the IBM PS/2 Model 70-E61 uses a 16-MHz 80386 and the Compaq Deskpro 386S uses the new Intel 80386SX. In performance, both of the machines tested provide the capability, functionality, storage space, memory capacity, and speed commensurate with any PC available today.

They also make owning a 386 computer affordable for the first time, significantly narrowing the price gap between the top of the 80286 computer line and the bottom of the 386 line. When the price differential between 286 and 386 machines narrows enough, Compaq and IBM are betting that many buyers will spend the extra dollars for the higher-performance chip. Machines such as the Deskpro 386S and PS/2 Model 70 may even lead to the eventual elimination of the 286 line.

COMPUTER GRAPHIC • NATALE/EAST


5.21
5.21
5.21
MSC2321-85YS18A
16MHz

COMPAQ DESKPRO 386S

This small-footprint Deskpro brings 386 power to any desktop.

The Compaq Deskpro 386S has a totally new look for Compaq, even beyond the small packaging and Intel 386SX processor. The keyboard has a new feel, and a mouse port finally is built into the system board, along with a serial port, a parallel port, and a VGA graphics controller. The power switch has moved to the front (see photo 1).

The machine's 386SX is a 386 with clogged arteries. It is a fully functional 386 processor that communicates with the world via a 16-bit data path, rather than the 386's standard 32-bit data path. Its address bus is limited to 24 bits, the same as the 286. It is about half the size of the 386 chip package and designed for surface mounting. Intel is currently producing the chip for operation at only a single speed—16 MHz.

In many respects, the 386SX is to the 386 what the 8088 was to the 8086. The 8088 used a 16-bit internal data structure but communicated over an 8-bit data bus. IBM chose the 8088 as its first PC to straddle the fence between a 16-bit CPU and the then-existing 8-bit world of software and hardware. In much the same way, the 386SX allows Compaq to straddle the line between an emerging 32-bit world of more powerful CPUs and what Compaq calls "industry-standard architecture," a well-established 16-bit world with myriad expansion boards that are compatible with the AT bus.

The Compaq 386S also has inherited many characteristics from its Compaq ancestors. The machine's internal circuitry and design provide an illustrated history of Compaq's PC development. The 16-MHz memory bus, only 16 bits wide because of the 386SX, uses the page mode for memory access introduced in the Compaq Deskpro 386 and used in the Portable 386. Application-specific integrated circuits (ASICs) and integrated hard-disk controllers are Compaq trademarks originally found in the Portable III. The integrated video graphics controller (VGC) provides full VGA functionality and features the 16-bit bus design used in Compaq's VGC board, introduced last year. Of course, the machine has a standard 8-MHz, 16-bit AT bus.

MINUSCULE MEASUREMENTS

The most noticeable feature of the Compaq 386S is its small size. Measuring 5.9 inches high by 14.8 inches deep by 15.8 inches wide, it is considerably smaller than the traditional Deskpro system unit. It is slightly taller than the IBM PS/2 models, allowing it to hold standard AT-bus expansion boards and a stack of three externally accessible storage devices (two third-height and one half-height). With a shortened keyboard, the entire unit has a depth of less than 22 inches, just right for a 24-inch-deep work surface.

The standard diskette drive is a third-height 1.2MB 5.25-inch drive. It is the only storage device on the entry-level Model 1; hard-disk drives of 20MB and 40MB are available with the Model 20 and Model 40 versions, respectively. Other storage-device options include a 1.44MB 3.5-inch diskette drive, a 40MB or 135MB hard-disk backup (tape drive), and a 110MB hard-disk drive. The machine can accommodate as many as four devices, but no more than two hard-disk drives.

Compaq offers an optional color or monochrome VGA monitor with the unit. Both monitors rest securely on top of the system unit, and they both provide good clarity and contrast. They really shine when coupled with the Compaq 16-bit VGA. By doubling the data-transfer rate, the VGA enhances performance significantly.

A full set of external connections is integrated into the system board. This includes a parallel port, a nine-pin serial port, a keyboard port, and an auxiliary port (for an IBM PS/2-compatible mouse). With these items on the system board, the four AT-bus slots are totally free in the standard machine. The system unit features a keylock in the rear of the machine that secures the cover; keyboard security is provided via a password stored in the battery-backed CMOS. These features provide security for data in the machine.

The 386S keyboard follows the IBM enhanced-keyboard layout. Compaq has changed its strategy on the keyboard cable so that the cable connects from the bottom of the keyboard to the back of the system unit. The keyboard is also notable in its feel and size. Compaq has finally abandoned its soft keys to add a little resistance to its keytops. There is no IBM click, but the keyboard, manufactured for Compaq by EECO Inc., uses rubber-dome technology (used by EECO in its Maxi-switch keyboard) to provide good tactile feedback. To keep the overall depth of the system unit and keyboard under 24 inches, Compaq has lopped off the template holder above the function keys. If you cannot run your favorite software package without the function-key template, you had better find another keyboard.

A TOUR INSIDE

The system unit cover comes off by loosening three thumbscrews on the rear of the unit. If the screws are too

COMPAQ DESKPRO 386S VITAL STATISTICS

Model 1: $3,799
16-MHz Intel 80386SX microprocessor
1MB memory
Intel 80387SX coprocessor socket
Realtime clock
Video Graphics Controller
Serial, parallel, and mouse interfaces
1.2MB 5.25-inch diskette drive
101-key enhanced keyboard

Model 20: $4,499
All features of Model 1 except with 20MB hard disk (3:1 interleave)

***Model 40: $5,199**
All features of Model 1 except with 40MB ESDI hard-disk drive (1:1 interleave)

Available options:
1MB, 100-ns memory module: $649
4MB, 100-ns memory module: $2,599
1MB system-memory expansion board: $699
*4MB system-memory expansion board: $2,699
*80387SX (16-MHz): $799
*Compaq Video Graphics Color Monitor: $699
Compaq Video Graphics Monochrome Monitor: $255
360KB 5.25-inch diskette drive: $225
1.2MB 5.25-inch diskette drive: $275
1.44MB 3.5-inch diskette drive: $245
20MB hard-disk drive: $999
40MB hard-disk drive: $1,549
110MB hard-disk drive: $3,499
*40MB tape-backup drive: $799
135MB tape-backup drive: $1,999
*MS-DOS/BASIC 3.3: $120
*MS-OS/2 Standard Edition 1.0: $325
**Compaq Deskpro 386S Technical Reference Guide*: $149

An asterisk indicates the model reviewed and the options included.

PHOTO 1: *Compaq Deskpro 386S*

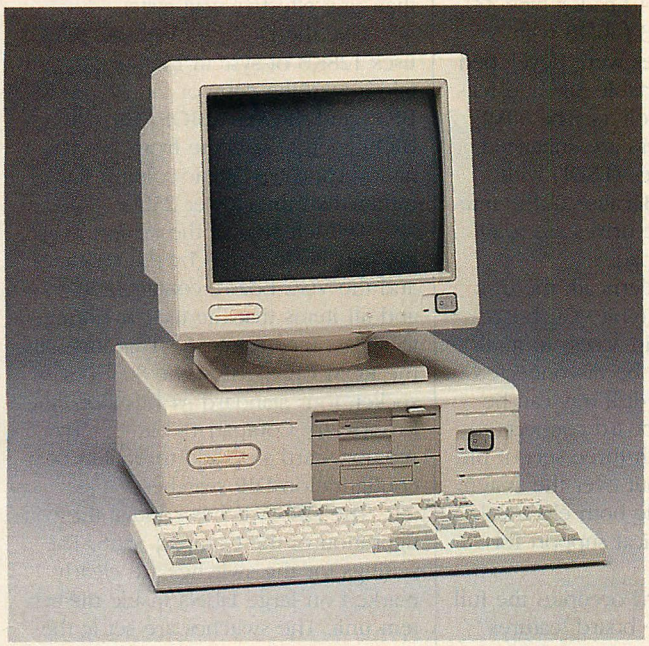
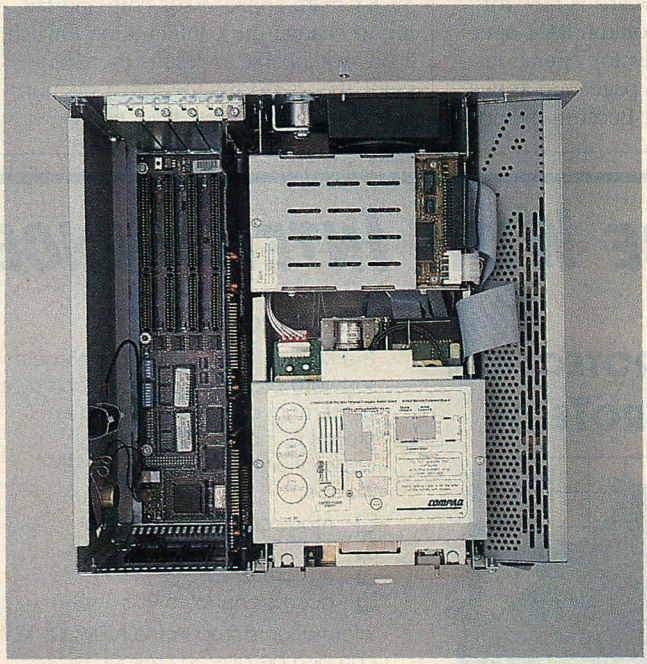


PHOTO 2: *Inside the System Unit*



At 15.8 inches wide by 14.8 inches deep by 5.9 inches high, the 386S is smaller than the traditional Deskpro.

Hard-disk and diskette drives are mounted in the center, connected to the system board via ribbon cables. The cooling fan is in the rear and the power supply is on the right.

The VGC board provides 16-bit VGA capability; it connects to the system board without requiring an expansion slot.

System-board features include four AT-type expansion slots and one slot for the proprietary 16-MHz memory board. The 386SX is to the right of the white-labeled BIOS chips.

The 16-MHz, 16-bit, 4MB memory board accommodates two additional memory modules, either of which can be 1MB or 4MB. A 1MB version of the board is also available.

PHOTO 3: *VGC Board*

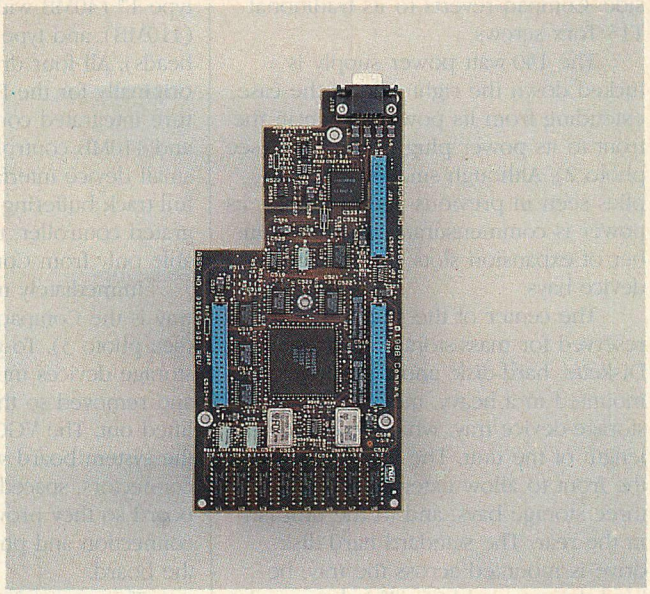


PHOTO 4: *System Board*

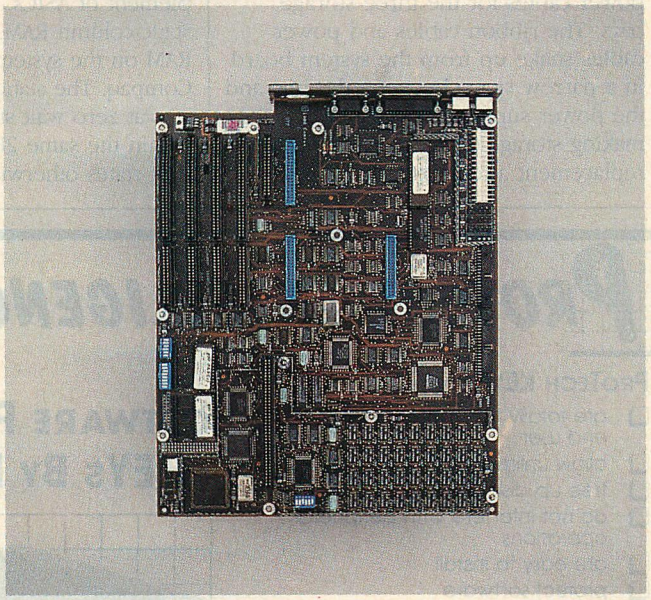
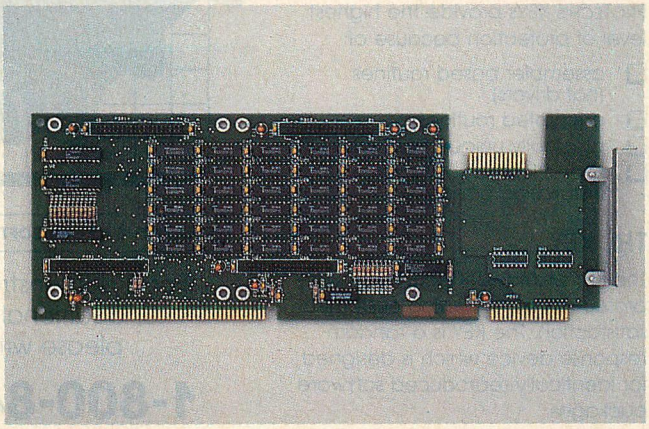


PHOTO 5: *4MB Memory Board*



tight, they can be persuaded with a handy dime or screwdriver. Once inside, Compaq reverts to its traditional T15 Torx screws.

The 140-watt power supply is tucked down the right side of the case, extending from its power switch in the front to its power plug in the back (see photo 2). Although smaller than supplies seen in previous 386 machines, its power is commensurate with the number of expansion slots and storage-device bays.

The center of the system unit is reserved for mass-storage devices. Diskette, hard-disk, and tape drives are mounted in a heavy, metal 5.25-inch storage-device tray, which runs the full length of the unit. The tray opens to the front to allow external access to three storage bays, and to the unit fan in the rear. The standard hard-disk drive is mounted across the tray, behind the external bays. This leaves a lot of space underneath it, but the space is filled with ribbon data cables and power cables for the three storage bays. The ribbon cables and power cables snake up from the system board in a narrow space between the tray and the power supply. The spacing is tight, making storage-device installation or replacement a tedious task.

Compaq supports four types of disk drives in the 386S: type 2 (20MB), type 17 (40MB with 4 heads), type 33 (110MB), and type 43 (40MB with 5 heads). All four drives were developed originally for the Portable 386 and feature integrated controllers. The 40MB and 110MB controllers are enhanced small device interfaces (ESDI) with full-track buffering. Because of the integrated controller, the drives are available only from Compaq.

Immediately underneath the disk tray is the Compaq 16-bit VGC board (see photo 3). To gain access to it, all storage devices must be disconnected and removed so the disk tray can be lifted out. The VGC board connects to the system board with three sets of pin connectors, spaced out over the system board so they provide both electrical connection and physical support for the board.

The system board occupies the full floor of the unit. The board features the surface-mounted 386SX, a full complement of ASICs, and 1MB of soldered static-column RAM. The use of soldered RAM on the system board is new for Compaq. The static-column RAM operates at zero wait states for operations within the same 2KB page, and at two wait states otherwise. Because memory operations tend to be clustered, this provides memory access at slightly less than one effective wait state.

Like the Deskpro 386, the 386S uses 128KB of system memory to contain a working copy of the system ROM BIOS and the VGC BIOS. This allows BIOS code to execute from the 100-nanosecond (ns) static-column RAM, rather than the slower 250-ns ROM.

The left side of the system board, the part not covered by the disk tray and the VGC board, contains the 386SX and all items that the user might need to access (see photo 4). This includes the ROM BIOS chips; the 80387SX socket; four standard AT-bus slots; the proprietary Compaq 16-bit, 16-MHz memory-card slot; and three sets of configuration DIP switches.

The DIP switches control the configuration of the Compaq 386S. The settings for the switches are clearly marked on large labels inside the system unit. The switches are set at the factory to conform to the initial machine configuration, and they are very important. For example, installing the 387SX math coprocessor chip and failing to change the configuration (switch 2 on switchbank 1) results in a computer that performs the initial memory check and then stops dead.

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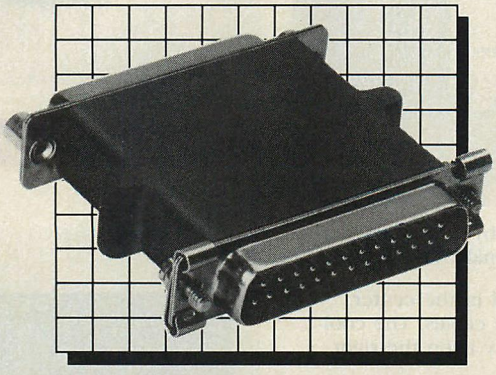
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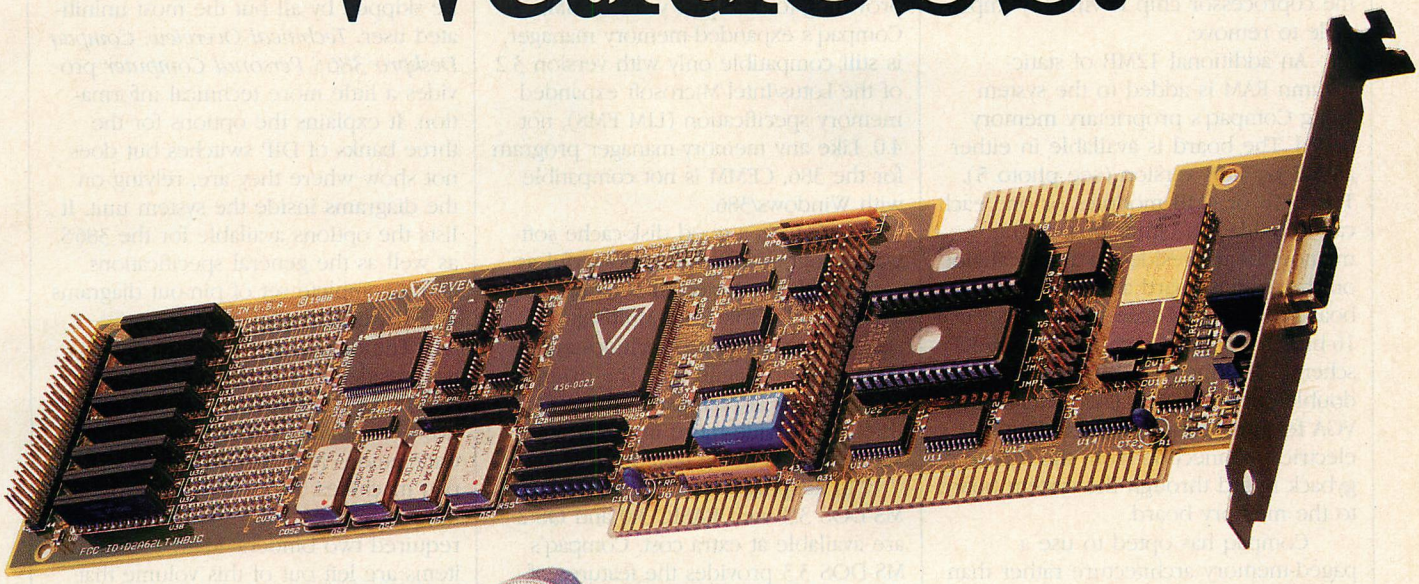
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- ❑ customization
- ❑ access control to PCs

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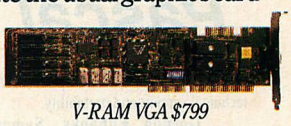
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The 387SX is a 68-pin leadless chip. Because there are no pins to misalign, it mounts easily in the chip-carrier socket on the system board. Removal, however, is another story. It requires a special tool, without which the coprocessor chip is virtually impossible to remove.

An additional 12MB of static-column RAM is added to the system using Compaq's proprietary memory board. The board is available in either a 1MB or 4MB version (see photo 5). Two 1MB or 4MB modules or one each can be added to either board. The memory board resides in a special slot on the system board and, like system-board memory, is accessed via a special 16-bit, 16-MHz bus with a 2KB paging scheme. The memory board serves double-duty in that it also contains the VGA feature connector, providing an electrical connection from the VGC piggyback board through the system board to the memory board.

Compaq has opted to use a paged-memory architecture rather than the memory cache controller used in the Deskpro 386/20 and 386/25. This choice eliminates the cost of the Intel 82385 cache controller and associated circuitry, with only a minimal decline in performance. However, because static-column RAM costs more than the dynamic RAM used in the caching machines, additional memory chips are more costly. An additional 4MB of memory for the Deskpro 386S costs $649, versus $549 for the 386/20 and 386/25. The cost for an additional 4MB of memory is $2,599 versus $2,099, a difference of almost 20 percent.

IN THIS CORNER

In the software arena, the Deskpro 386S offers nothing new. The standard user software includes the same four programs—CEMM, CACHE, INSTALL, and SETUP—that Compaq has been providing for the past year. CEMM, Compaq's expanded-memory manager, is still compatible only with version 3.2 of the Lotus/Intel/Microsoft expanded memory specification (LIM EMS), not 4.0. Like any memory-manager program for the 386, CEMM is not compatible with Windows/386.

CACHE is a good disk-cache software program but not as powerful as some of the commercial versions, such as Super PC-Kwik from Multisoft. The standard software also includes a diskette of user diagnostics. The diagnostic programs are similar to those for IBM but provide more information about what is being tested.

In keeping with Compaq tradition, MS-DOS 3.3 with BASIC 3.0 and OS/2 are available at extra cost. Compaq's MS-DOS 3.3 provides the features of IBM's PC-DOS 3.3 with some extras. The primary addition is the ability to have logical drives (volumes) larger than 32MB. MS-DOS 3.3, as published by Compaq, allows logical drives with as much as 512MB.

Not-so-deep documentation. Compaq's documentation for the 386S is written on an elementary level with little technical depth. Divided into three booklets, it looks somewhat like a comic book with many illustrations and sparse text. The *User Program Reference* describes the standard software available with all Compaq computers and can be confusing because of the wide variety of computers covered.

Getting Started: Compaq Deskpro 386S Personal Computer is a short booklet illustrated entirely with photos. Written on an elementary level, it can be skipped by all but the most uninitiated user. *Technical Overview: Compaq Deskpro 386S Personal Computer* provides a little more technical information. It explains the options for the three banks of DIP switches but does not show where they are, relying on the diagrams inside the system unit. It lists the options available for the 386S, as well as the general specifications and a complete set of pin-out diagrams for all external connections.

The only really technical information resides in the *Compaq Deskpro 386S Technical Reference Guide*. It, however, is not as substantial as reference guides have been for other Compaq machines. It fits in one 2-inch binder, whereas all previous guides required two binders. Many technical items are left out of this volume that were described in earlier guides—such as what the ASICs are and what they do, information on the integrated disk-drive controller, and a specific statement on speed of the system memory chips. Hardware information is limited to pin-out diagrams and general specifications sheets. For example, the built-in ESDI controllers on the hard-disk drives are not detailed.

For buyers of MS-DOS or OS/2, Compaq includes its version of the appropriate manual. A guide to tape-drive operations and the TAPE utility is included with the tape drives.

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Check Out These Reviews

- **High C ™:**

Computer Language	February 1986, '87	
Dr. Dobb's Journal	August 1986	
PC Magazine	Jan. 27, 1987	(80386)
Dr. Dobb's Journal	July 1987	(80386)
BYTE Magazine	Nov. 1987	(80386)

- **Professional Pascal ™:**

PC Magazine	Dec. 29, 1985
Computer Language	May 1986
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IBM PS/2 MODEL 70-E61

This 16-MHz entry-level Model 70 is the gateway to IBM's 386 product line.

The PS/2 Model 70 series fills a big gap in the IBM product line. By providing a desktop 386 machine in three different speeds (16 MHz, 20 MHz, and 25 MHz) at competitive prices, IBM is trying to regain some of the power-user market it has lost to Compaq and others. The 25-MHz version was reviewed last month (see "100 MHz of Performance," David Claiborne and Jim Shields, September 1988, p. 66).

The Model 70-E61, with its 16-MHz speed and 60MB hard-disk drive, is the entry point for the new line and the model most similar to Compaq's 386S. The Model 70 case is the same size as that of the PS/2 Model 50 (see photo 1). It is shorter (5.5 inches versus 5.9) and narrower (14.1 inches versus 15.8) than the Compaq Deskpro 386S, but it is deeper (16.5 inches versus 14.8). This depth, coupled with an 8.2-inch keyboard depth, means that the computer does not fit on a 24-inch-deep work surface without hanging over.

The system unit is light, weighing 21 pounds. This is due to IBM's tightly integrated assembly and extensive use of molded plastic for the interior structure. The only metal in the unit's structure is the exterior case and the power-supply covering.

A 1.44MB 3.5-inch diskette drive is standard. Two storage bays have external access on the front of the unit. The empty bay can be used for another 3.5-inch diskette drive or an adapter for the connection of an IBM external 360KB 5.25-inch diskette drive. The Model 70 accommodates only a single hard-disk drive. In the Model 70-E61, the drive is 60MB.

The unit features IBM's standard VGA controller, which can accommodate a variety of VGA monochrome and color monitors. The review unit had the 8513, a VGA color monitor.

The system board has a full complement of integrated external connections, including a parallel port, 25-pin serial port, and keyboard, auxiliary (mouse), and VGA ports. The unit also features a keylock located in the rear, plus a keyboard password feature. The keyboard is the standard 101-key IBM enhanced version.

IT'S A SNAP

When the cover is removed from the Model 70 (by loosening two thumbscrews), the real beauty of the unit shines through. What is first evident is what is *not* there: no ribbon cables, no power cables, no configuration switches or jumpers, and hardly any screws. The entire unit is designed to plug in and snap together in minutes.

As in the Compaq Deskpro 386S, the power supply extends down the right side of unit (see photo 2). Like the Compaq model, the power supply is small, only 135 watts, but sufficient for the number of storage bays and expansion slots. Unlike the Compaq, the system board plugs directly into the power supply.

The storage devices rest on a raised plastic shelf in the center of the unit and connect to the system board via a circuit board that rises from the floor of the unit to the middle of the panel. The circuit-board connector provides both electrical power and data connection for the storage devices. The two diskette drives attach to the front of the connector, while the hard-disk drive plugs into the rear. All devices snap in, held in place by integrated spring catches in the support panel. All drives can be snapped quickly. Given the small size of the hard-disk drive and the ease of installing and removing it, a person could carry a disk drive from location to location.

IBM offers only a 60MB drive with the Model 70-E61, although a 120MB drive is used in a 20-MHz 121 model and the 25-MHz A21 model. Both drives feature an integrated ESDI controller with 1:1 interleave. IBM, however, provides only a 1KB buffer in the controller. Because of this, the controller can buffer only two sectors, rather than an entire track. The lack of full-track buffering penalizes the Model 70's performance in disk-intensive tasks compared with other computers.

Beneath the storage shelf is the system board. Most components requiring access are in the uncovered portion on the left side of the unit. The one exception is the system-board memory modules, but a special opening is cut in the platform to allow the memory modules to be installed or removed with the storage shelf.

The system board contains sockets for three single in-line memory modules (SIMMs), as shown in photo 3. The standard configuration has one socket filled with a 100-ns, 1MB SIMM. The sockets can be filled with 1MB or 2MB SIMMs, yielding a 6MB capacity for the system board. The memory is accessed using a 2KB paging scheme. Memory reads within the same page occur with zero wait states; writes require one wait state; and reads or writes outside the page require two wait states. Additional memory can be installed using expansion boards in the Micro Channel slots to bring the system total to 16MB.

Available memory-expansion boards include the 2-8MB 386

IBM MODEL 70-E61 VITAL STATISTICS

***Model 70-E61: $5,995**
16-MHz Intel 80386 microprocessor
1MB memory
Intel 80387 coprocessor socket
Realtime clock
Video Graphics Array
Serial, parallel, and mouse interfaces
1.44MB 3.5-inch diskette drive
60MB ESDI hard disk
101-key enhanced keyboard

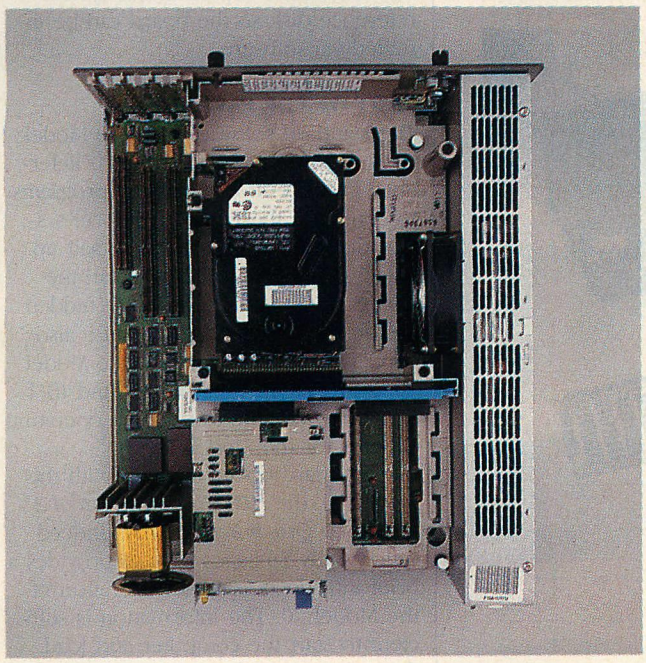
Available options:
*2-8MB 80386 memory-expansion board: $1,695
1MB, 85-ns memory module: $695
*2MB, 85-ns memory module: $1,395
*80387 math coprocessor (16-MHz): $795
8503 monochrome display: $250
8512 color display: $595
*8513 color display: $685
8514/A display adapter: $1,290
8514/A display-adapter memory expansion: $270
8514 color display: $1,550
Second 1.44MB 3.5-inch diskette drive: $245
360KB 5.25-inch external diskette drive: $335
5.25-inch external diskette-drive adapter/A: $60
*PS/2 Mouse: $95
6157 Model 1 streaming-tape backup drive: $1,750
PS/2 6157 tape-drive interface/A: $350
*IBM PC-DOS/BASIC 3.3: $120
IBM PC-DOS 4.0: $150
*IBM OS/2 Standard Edition, version 1.0: $325
**IBM PS/2 Hardware Interface Technical Reference: $125*

An asterisk indicates the model reviewed and the options included.

PHOTO 1: *IBM PS/2 Model 70-E61*



PHOTO 2: *Inside the System Unit*



The Model 70 system case is nearly identical to that of the Model 50. Only the logo indicates that it is a 386 system.

The interior features plastic construction. All devices are connected directly; there are no connecting cables.

The system board includes three Micro Channel expansion slots: one 16-bit slot with video extension and two 32-bit slots. SIMM connectors are located at the lower right.

The 2-8MB 32-bit memory board comes with one 2MB SIMM installed. Three additional 1MB or 2MB SIMMs can be installed, without having to set any jumpers or switches.

The SIMM uses 85-ns chips mounted on both sides of a small printed circuit board. A 1MB version is also available.

PHOTO 3: *System Board*

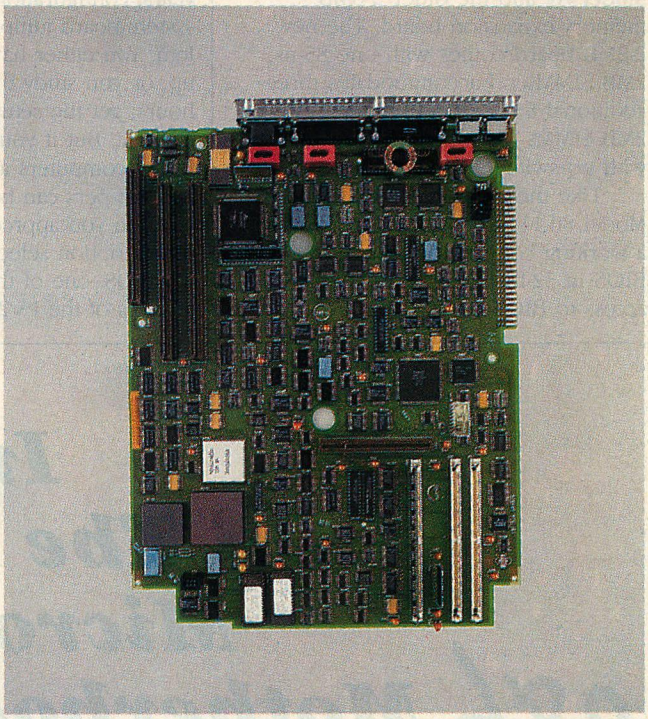


PHOTO 4: *2-8MB Memory Board*

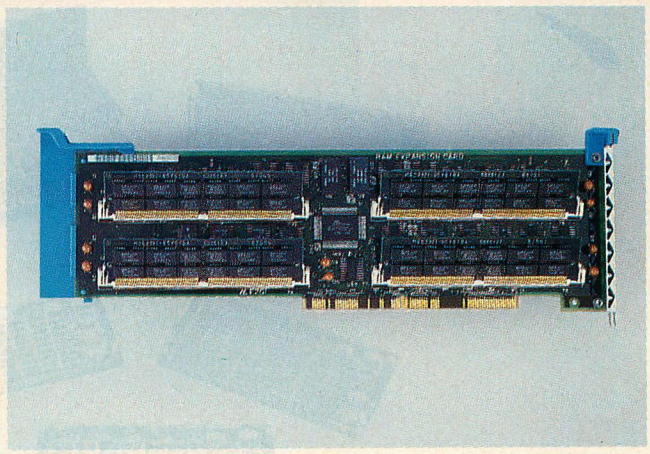
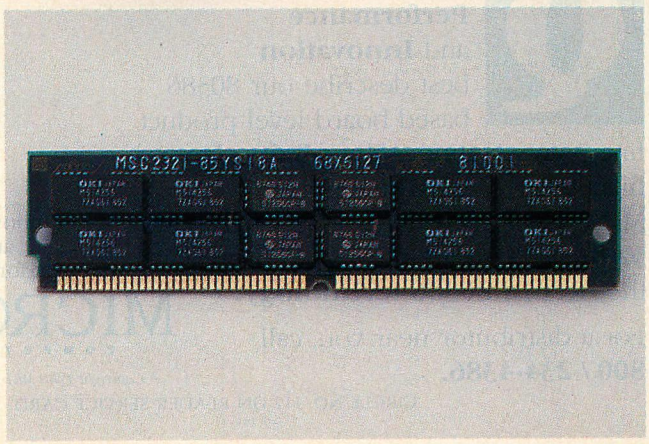


PHOTO 5: *2MB SIMM*



memory-expansion board (see photo 4), introduced at the same time as the Model 70, and the older 2-6MB memory-expansion board. The new 2-8MB board comes with one 85-ns, 2MB SIMM and accommodates three additional 85-ns SIMMS. Either 1MB or 2MB SIMMs (see photo 5) can be used, with no switch setting required.

Like the Deskpro 386 and the PS/2 Model 80-111, the Model 70 maintains a working copy of the system ROM BIOS in 32-bit memory to speed up access to BIOS code.

IBM's greatest gift. For anyone buying only one computer every three or four years, configuration switches and system-board jumpers are not a problem. You either have the dealer set it up, or you study the manual a few hours, get the setup correct, and forget about it. But if you set up several different computers a month, switches and jumpers can be a nightmare. That is when you appreciate IBM's programmable option selection (POS).

POS, one of the trademark characteristics of the PS/2 series, sets all the system configurations via software. The settings are stored in the system's CMOS RAM.

To set up the Model 70, simply load the reference disk and follow the instructions. To add or subtract system components, just run the configuration program again. Most PS/2 expansion boards have their own POS information, which must be copied to the reference disk as they are acquired. But other than that, setup is automatic. In reality, the Model 70 has few options. You can install a 387 math coprocessor and add a second diskette drive, system-board memory, or a Micro Channel expansion board. In all cases, each option can be installed in less than five minutes.

Access to the 387 socket is easy, but it requires removing any expansion boards. System-board memory connectors are also easy to get to unless the second diskette drive is installed. If this is the case, the drive can be snapped in and out in 30 seconds. When expansion boards are added, they drop right in. The particular POS program for the board must be copied to the system reference disk so the board can be installed via software.

PART OF THE PACKAGE

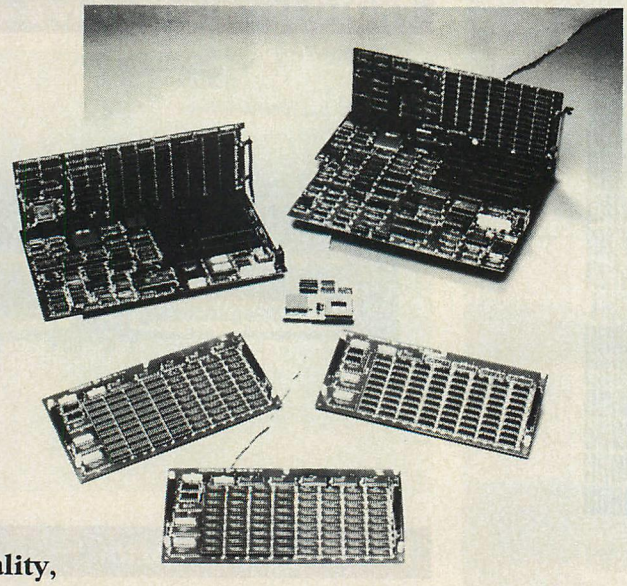
The standard software with the Model 70 is the IBM PS/2 Model 70/80 Reference Diskette. It contains the programs to configure the POS, to perform system diagnostics, and to back itself up. IBMCACHE, a program to install the disk caching, is contained in a hidden file on the diskette. The diskette also contains a short tutorial on the Model 70. PC-DOS 3.3, PC-DOS 4.0, and IBM OS/2 are available as optional operating systems for the Model 70.

Standard documentation with the Model 70, the *IBM Personal System/2 Model 70 Quick Reference*, is indeed quick. Only 58-pages long, it provides a brief introduction to the operation of the Model 70. The information is sufficient to start the computer and load the reference diskette information, but not much else.

If more technical information is desired, IBM provides a wealth of additional documentation at extra cost, including separate manuals on hardware maintenance, hardware interfaces, and all PS/2 options.

If one of the IBM operating systems is purchased, it comes with a complete manual. As in the case of the IBM hardware, additional operating-system details are available in more technical references.

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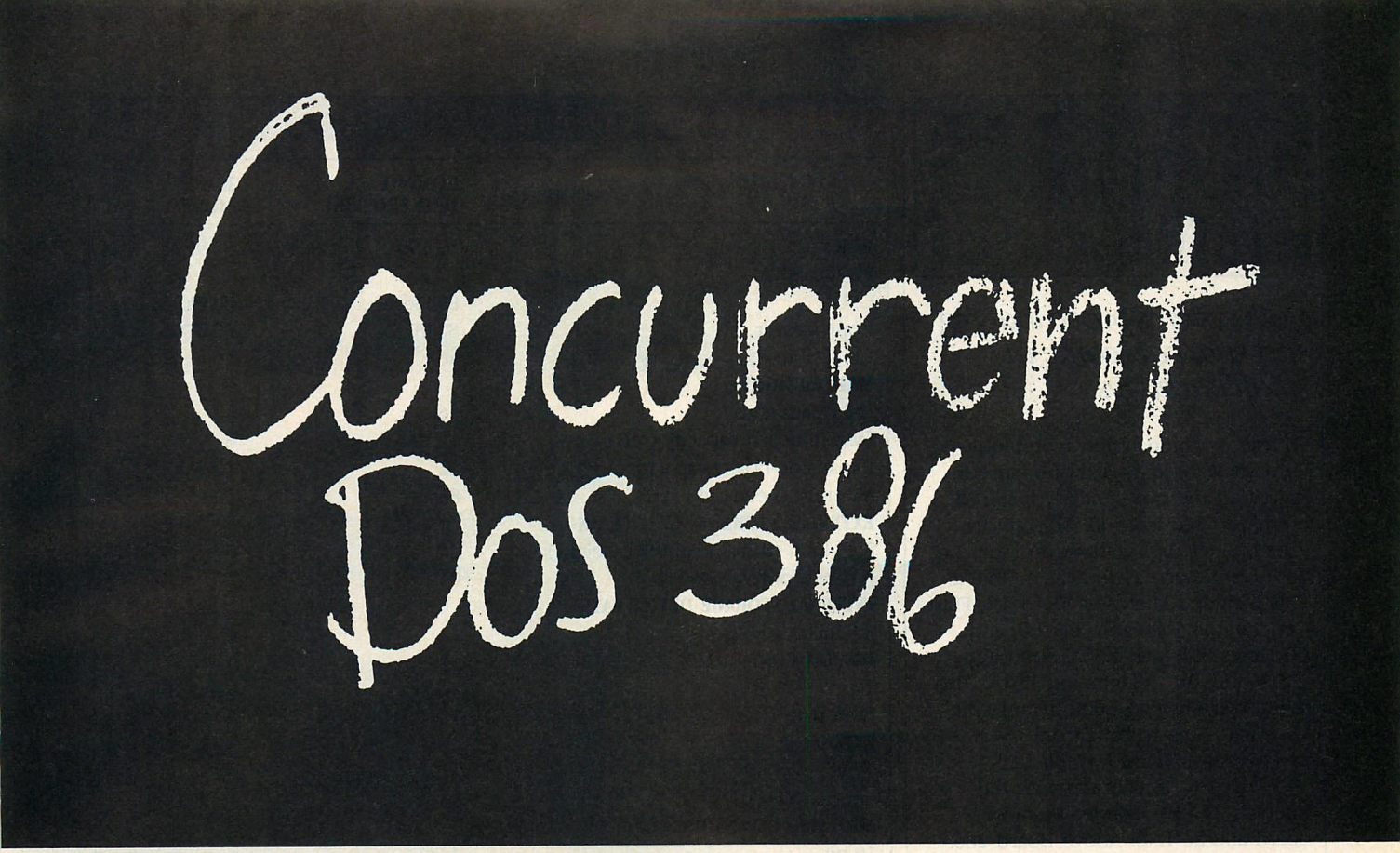
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TOE-TO-TOE TESTING

Both systems prove that big surprises can come in small packages.

To test for compatibility, commonly used software and hardware were installed on the two similarly featured machines (see table 1). All software tested functioned without problem on both computers, as shown in table 2. This included Microsoft Word 4.0, Fifth Generation's Fastback Plus 1.0, and Borland's SideKick 1.56A, SuperKey 1.16A, and Turbo Lightning 1.01A. Also tested were Ready! 1.00E from Living Videotext, Smartcom II from Hayes, and Microsoft Windows/386 2.03.

The 386S was tested with the Cheetah 2.5MB extended-memory board and an Intel Above Board 286. Both boards worked without problem; the Above Board was configured for both expanded- and extended-memory use. Hayes 1200B and 2400B Smartmodems functioned without problem, as did the Microsoft bus mouse.

The 386S adheres to industry-standard architecture by containing four 8-MHz, 16-bit AT-bus slots plus the proprietary memory-board slot. Because the Model 70 does not subscribe to the industry-standard architecture, it was not tested with any add-in boards other than the IBM 2-8MB 386 memory-expansion board. External devices tested worked well.

TABLE 1: *Features Summary*

	COMPAQ DESKPRO 386S	IBM PS/2 MODEL 70-E61
PRICE[a]	$5,199	$5,995
PROCESSORS		
CPU	80386SX	80386
Coprocessor	80387SX	80387
Clock rate of processors (MHz)	16	16
MAIN MEMORY		
Data path (bits)	16	32
System-board capacity (MB)	1	6
Expansion-board capacity (MB)	12	10
Memory speed (ns)	85	100
EXTERNAL STORAGE-DEVICE BAYS		
5.25-inch (third-height/half-height)	2/1	0
3.5-inch only	0	2
INTERNAL STORAGE-DEVICE BAYS		
3.5-inch only	1	1
DISPLAY CONTROLLER		
Type	VGA	VGA
Data path (bits)	16	8
EXPANSION BUS		
Type	AT	MCA
Speed (MHz)	8	10
AVAILABLE EXPANSION SLOTS		
16-bit	4	1
32-bit	0	2
PORTS		
Serial	1	1
Parallel	1	1
Pointing device	1	1
POWER SUPPLY		
Capacity (watts)	140	135
ELECTROMAGNETIC COMPATIBILITY		
FCC Class	B	B
DIMENSIONS		
Width (inches)	15.8	14.1
Depth (inches)	14.8	16.5
Height (inches)	5.9	5.5
Weight (pounds)	28	21

[a] *The price is for a unit with one diskette drive, a 40MB (Compaq) or 60MB (IBM) hard-disk drive, 1MB of memory, and high-resolution (640-by-480 pixel) VGA color graphics controller.*

Both systems have similar features. Compaq offers a 16-bit memory data path, a 16-bit VGC, and an AT-type, 16-bit expansion bus; the PS/2 Model 70-E61 has a 32-bit data path, an 8-bit VGA, and a 16/32-bit Micro Channel expansion bus.

THE UPPER HAND

The performance of both the Compaq Deskpro 386S and the IBM Model 70-E61 was tested using the full set of *PC Tech Journal*'s high-level benchmarks. (See "High-level Measurements," Kent Quirk, September 1988, p. 54.) These benchmarks measure system performance using programs that simulate aspects of typical applications. HLTEXT and HLWINDOW measure the performance of the video adapter/monitor combination. HLGRAPH gauges a mix of processing speed and graphics capability. HLSORT and HLFLOAT measure the flat-out speed of the processor and memory. HLDISK performs typical database operations.

The results of the benchmark tests are shown in table 3 and figure 1. Test values for the Compaq Deskpro 286 and the Deskpro 386, the first widely available 386, are shown for comparison. The two new machines are slower in all tests than the 16-MHz Deskpro 386. The 386S is hindered by its 16-bit data path and the Model 70 by its one-wait-state memory writes. All three machines are significantly faster than the 12-MHz Deskpro 286.

Comparing the benchmark results for the 386S and the Model 70 reveals that the Model 70 performs the CPU/sort test 10-percent faster than the 386S, but that the 386S is faster when performing the video and disk-performance tests. In the video tests, the Deskpro 386 and 386S with their 16-bit VGC were twice as fast as the Model 70 with its 8-bit VGA.

The IBM disk-drive controller, with its two-sector buffer, is almost 50-percent slower than the Compaq Deskpro 386 and 386S machines with full-track buffering. The difference narrows to 15 percent when disk caching is used on the computers, but IBM disk operations are still slower.



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	Computer	Memory	Hardware Software Compatibility	I/O Piggyback Modules (optional)
RampagePlus/MC	PS/2 Model 50/60	up to 8 MB	EMS 4.0 EEMS EMS 3.2 OS/2	Serial Serial or Serial Parallel
RampagePlus 286	AT or Compatible (XT form factor)	up to 8 MB	EMS 4.0 EEMS EMS 3.2 OS/2	Serial Serial or Serial Parallel

By making the one simple decision to buy RampagePlus, you can postpone making a lot of other decisions. If you're asking yourself: Do I need the extra functionality of EMS 4.0? Should I plan on converting to OS/2? Can I get the same power from my AT compatible as I can with a PS/2? Will I need to save slots for input/output boards? RampagePlus takes care of it all.

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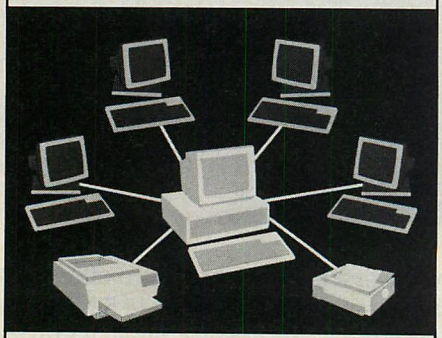
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TABLE 2: *Compatibility Summary*

	COMPAQ DESKPRO 386S	IBM PS/2 MODEL 70-E61
SOFTWARE		
Borland International		
Lightning 1.01A	●	●
SideKick 1.56A	●	●
SuperKey 1.16A	●	●
Fifth Generation Systems		
Fastback Plus 1.0	●	●
Living Videotext		
Ready! 1.00E	●	●
Microsoft Corporation		
Windows/386 2.03[a]	●	●
Word 4.0	●	●
HARDWARE		
Cheetah Systems		
Cheetah Card with 2.5MB	●	N/A
Hayes Microcomputer Products		
1200B Smartmodem	●	N/A
2400B Smartmodem	●	N/A
Intel Corporation		
Above Board 286 with 2.0MB	●	N/A
Microsoft Corporation		
Bus Mouse	●	N/A
Serial Mouse	●	●

● = *Yes* *N/A = Not applicable*

[a] *Windows/386 will not run if vendor software that provides expanded memory using extended memory is loaded.*

Both systems ran all standard software without problems. Because both are 386 systems, they support Microsoft Windows/386 and its ability to run multiple simultaneous DOS applications. All AT expansion boards worked with the 386S.

One reason for choosing the Compaq Deskpro 386S with its 16-bit memory bus is that few programs currently exist that use the full capability of the 386 and its 32-bit operators and 32-bit memory. One that does is Paradox, a relational data manager from Ansa Software, now a part of Borland International. Paradox was reviewed in April 1986 (see "A Data Manager with Visual Queries," Will Fastie, p. 154).

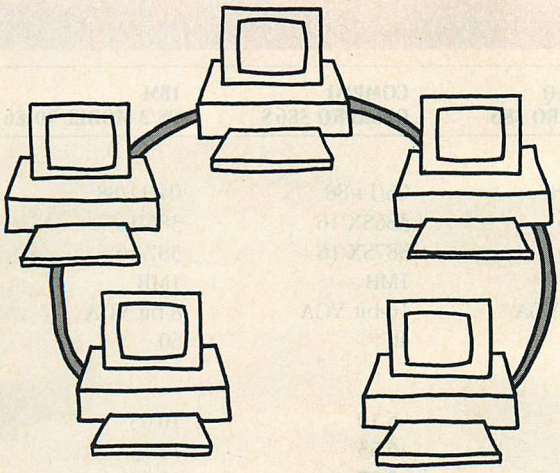
The Compaq 386S, the IBM Model 70-E61, and the Deskpro 386 were all tested using Paradox/386 and data-manager tests developed by *PC Tech Journal* (see "Evaluating Data Managers as Development Tools," Julie Anderson, August 1985, p. 46). These tests consist of five typical database operations.

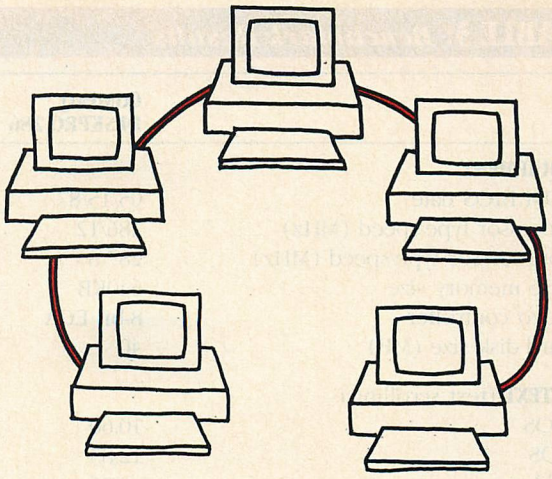
The same tests were performed on the Deskpro 286 using Paradox 2.0. They were performed on each machine with the programs and data stored on the hard disk with a 1MB extended-memory disk cache in use. The 386S was faster overall than the Model 70, because of its superior hard-disk performance (see table 4). The Deskpro 386 was about 10-percent faster than either because of its faster memory performance, and the Deskpro 286 took more than half as long as the 386S and the Model 70, mainly because of its slower hard disk.

To eliminate the effects of disk performance, both the programs and the data were stored on an extended-memory RAM disk. The results show that the Deskpro 386 is faster than either the 386S or the Model 70, and that the 386S holds its own with the Model 70. The Model 70 is 20-percent faster when building the indexes but only 10-percent faster overall. The Deskpro 286 is from two to ten times as slow as the other systems, with an overall time that is twice as long.

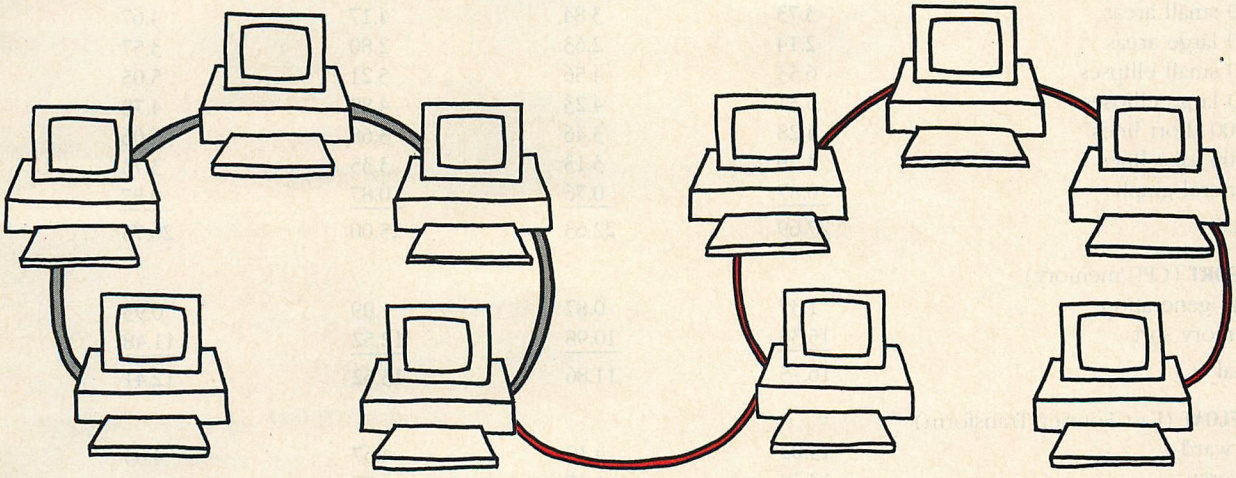
STANDOFF TO THE END

On the whole, both the Compaq Deskpro 386S and the IBM PS/2 Model 70-E61 are well-engineered, high-performance desktop computers. In many respects, they are almost identical in function, performance, and price. Both provide a great deal of computational





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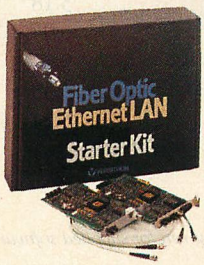


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TABLE 3: *Benchmark Results*

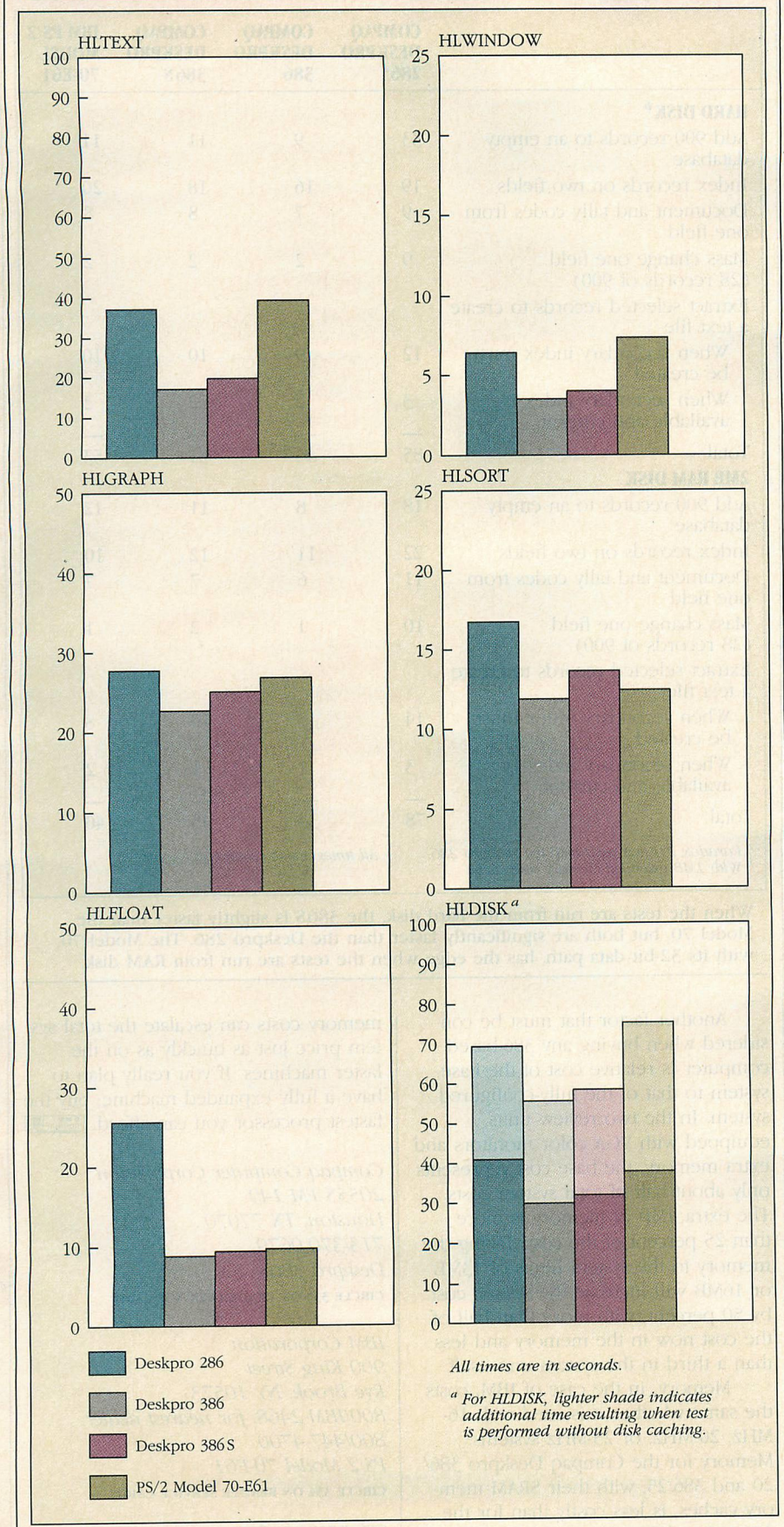
	COMPAQ DESKPRO 286	COMPAQ DESKPRO 386	COMPAQ DESKPRO 386S	IBM PS/2 MODEL 70-E61
EQUIPMENT				
ROM BIOS date	05/15/87	04/27/87	06/14/88	04/11/88
Processor type/speed (MHz)	286/12	386/16	386SX/16	386/16
Coprocessor type/speed (MHz)	287/8	387/16	387SX/16	387/16
Base memory size	640KB	1MB	1MB	1MB
Video controller	8-bit EGA	16-bit VGA	16-bit VGA	8-bit VGA
Hard-disk size (MB)	40	40	40	60
HLTEXT (text scrolling)				
BIOS	10.60	4.34	5.10	10.65
DOS	12.85	5.71	6.53	12.63
C library	9.56	4.56	5.27	11.64
Windowed	4.23	2.47	2.80	4.45
Total (text scrolling)	37.25	17.08	19.72	39.39
HLWINDOW (window/scrolling)				
Total	6.42	3.51	4.01	7.36
HLGRAPH (16-color graphics)				
400 small areas	3.73	3.84	4.17	4.67
100 large areas	2.14	2.63	2.80	3.57
400 small ellipses	6.53	4.56	5.21	5.05
200 large ellipses	6.31	4.23	4.89	4.78
4,000 short lines	4.28	3.46	3.68	4.06
2,000 long lines	3.79	3.13	3.35	3.73
General graphs	0.87	0.76	0.87	0.87
Total	27.69	22.63	25.00	26.75
HLSORT (CPU/memory)				
Data generation	1.37	0.87	1.09	0.93
Memory sort	15.38	10.98	12.52	11.48
Total	16.75	11.86	13.62	12.41
HLFLOAT (Fast Fourier Transform)				
Forward	13.02	4.39	4.67	4.83
Reverse	12.58	4.45	4.72	4.83
Total	25.60	8.84	9.39	9.67
HLDISK (with disk cache)[a]				
Data file creation	3.35	3.18	3.02	3.07
Index file creation	28.24	20.32	22.14	24.72
First report generation	2.41	1.48	1.70	1.64
Data reorganization	5.16	3.73	3.95	6.42
Second report generation	1.53	1.09	0.93	1.81
Total	40.93	29.83	31.86	37.74
HLDISK (without disk cache)				
Data file creation	3.40	3.18	3.02	3.07
Index file creation	34.39	26.04	31.31	35.49
First report generation	11.20	9.67	8.95	13.73
Data reorganization	16.64	13.35	13.95	19.28
Second report generation	3.46	3.24	1.04	3.46
Total	69.34	55.54	58.35	75.16

All times are in seconds.

[a] *The 256KB extended-memory disk cache was implemented using vendor-supplied software.*

The 386S with its 16-bit VGC and fast disk subsystem provides superior video and disk performance; the Model 70 offers slightly faster CPU/memory performance. While slower than the Deskpro 386, both are faster than the Deskpro 286.

FIGURE 1: *Performance Comparison*



The 386S has the edge in raw disk performance, but the gap narrows considerably when disk-caching software is used. Both are faster than the Deskpro 286.

power and have the necessary external connections directly from the system board. Both have ample expansion capability for an entry-level 386 system and come with excellent extra-cost technical documentation. The two machines have clear differences, however.

The 386S has faster disk drives and a faster display. It allows the installation of as much as 220MB of hard-disk memory, while the model 70 comes only in a 60MB configuration. The 386S can fit on a 24-inch-deep work surface, and it provides compatibility with industry-standard architecture. It offers four 16-bit AT-style expansion slots that accommodate a wide array of expansion boards.

The Model 70 has the edge with regard to ease of installation, setup, and maintenance. The engineering that goes into the PS/2 computer cannot be appreciated fully until it is disassembled and reassembled with no tools in minutes. The processor, with its 32-bit data bus, demonstrates a slight advantage in memory-access-intensive operations, as shown by the HLSORT benchmark and Paradox/386 data-manager test results. The Model 70 can accommodate as much as 6MB of memory on the system board (by replacing the standard 1MB module with a 2MB module), versus 1MB on the 386S.

In addition, IBM provides compatibility with Micro Channel architecture. The Model 70's two 32-bit and one 16-bit Micro Channel expansion slots allow for as much expansion as most desktop users will need. However, users requiring more expansion capability may have to consider other systems, including the floor-standing Model 80.

System cost is a toss-up. At $5,995, the base Model 70-E61 lists for $800 more than the Compaq 386S Model 40; however, the Model 70 includes 20MB more disk space. IBM memory modules cost about 10 percent more than Compaq's. Both offer significant 386 performance for less than the $7,098 cost of a VGC-equipped Deskpro 386.

Both machines are good, entry-level 386 computers. They are significantly faster than 10- and 12-MHz 286 systems, plus they can run 32-bit software, including control programs that allow the simultaneous execution of multiple DOS applications. Moreover, they do it at a cost not much greater than that of high-end 286 systems. For example, a comparably equipped 12-MHz Deskpro 286 costs $4,963, and a 10-MHz IBM Model 50Z with a 60MB hard-disk drive is $4,595.

TABLE 4: *Paradox/386 Benchmark Results*

	COMPAQ DESKPRO 286[a]	COMPAQ DESKPRO 386	COMPAQ DESKPRO 386S	IBM PS/2 MODEL 70-E61
HARD DISK[b]				
Add 900 records to an empty database	33	9	11	11
Index records on two fields	19	16	18	20
Document and tally codes from one field	9	7	8	8
Mass change one field (28 records of 900)	9	2	2	2
Extract selected records to create a text file				
When secondary index must be created	12	9	10	10
When secondary index is available and current	3	2	2	2
Total	85	45	51	53
2MB RAM DISK				
Add 900 records to an empty database	18	8	11	12
Index records on two fields	22	11	12	10
Document and tally codes from one field	11	6	7	7
Mass change one field (28 records of 900)	10	1	2	1
Extract selected records to create a text file				
When secondary index must be created	14	7	10	8
When secondary index is available and current	3	1	1	2
Total	78	34	43	40

[a] *Paradox 2.0 was used with the Deskpro 286.*
[b] *With 1MB extended-memory disk cache.*

All times are in seconds.

When the tests are run from the hard disk, the 386S is slightly faster than the Model 70, but both are significantly faster than the Deskpro 286. The Model 70, with its 32-bit data path, has the edge when the tests are run from RAM disk.

Another factor that must be considered when buying any 386-based computer is relative cost of the base system to that of the fully-configured system. In the two review units, equipped with VGA color monitors and extra memory, the base cost represents only about half of total system costs. The extra 4MB of memory is more than 25 percent of the cost. Taking the memory to the system limits of 13MB or 16MB will increase the system cost by 50 percent, with more than half of the cost now in the memory and less than a third in the system unit itself.

Memory, in the case of IBM, costs the same whether it is used with 16-MHz, 20-MHz, or 25-MHz systems. Memory for the Compaq Deskpro 386/20 and 386/25, with their SRAM memory caches, is less costly than for the 386S. So while you may save a little initially by buying a slower processor, memory costs can escalate the total system price just as quickly as on the faster machines. If you really plan to have a fully expanded machine, buy the fastest processor you can afford.

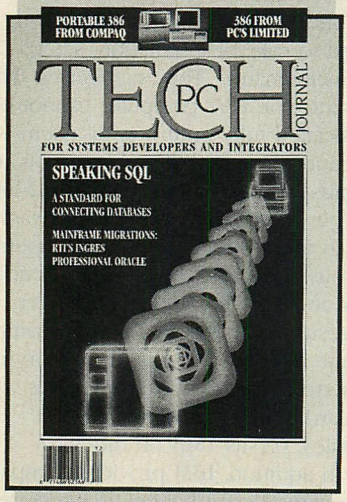
Compaq Computer Corporation
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Houston, TX 77070
713/370-0670
Deskpro 386S
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IBM Corporation
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Rye Brook, NY 10573
800/IBM-2468; for nearest dealer,
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David Claiborne is a technical manager for JAYCOR in Edgewood, Maryland.

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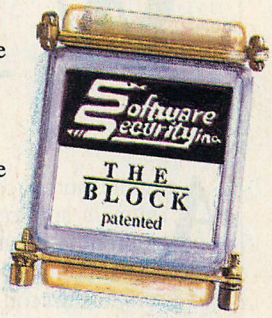
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Omnis Quartz Opens Windows

The Windows-oriented developer of data-management applications will find Omnis Quartz a rich environment, if complex to learn. The payoff is a graphics interface that is more approachable for many end users.

DAVE BROWNING

A graphics interface for data management applications is an exhilarating idea. Database structures typically are complex and foreign to end users; using icon representation for data tables and other objects and creating visual presentations of relationship linkages can prove very beneficial. Blyth Software's Omnis Quartz takes the first step toward integrating the graphics interface with data management, but a small step, directed more toward program operation processes than database and application design.

Inspired by Blyth's multiuser database software for the Apple Macintosh, Omnis 3 Plus, Quartz was designed to penetrate the IBM PC market. Quartz was developed for Microsoft Windows—not just as a quick-and-dirty port of a text-based application. The program is well-integrated into the graphics environment, using the windows and mouse for menu operations and data window management. Developing or using a Quartz application is instinctive for those who are familiar with Windows. (See "Windows of Opportunity," Paul Grayson, February 1987, p. 70 and "Windows Memory Management," Guy Quedens and Steven Armbrust, October 1987, p. 66 for background on Windows.)

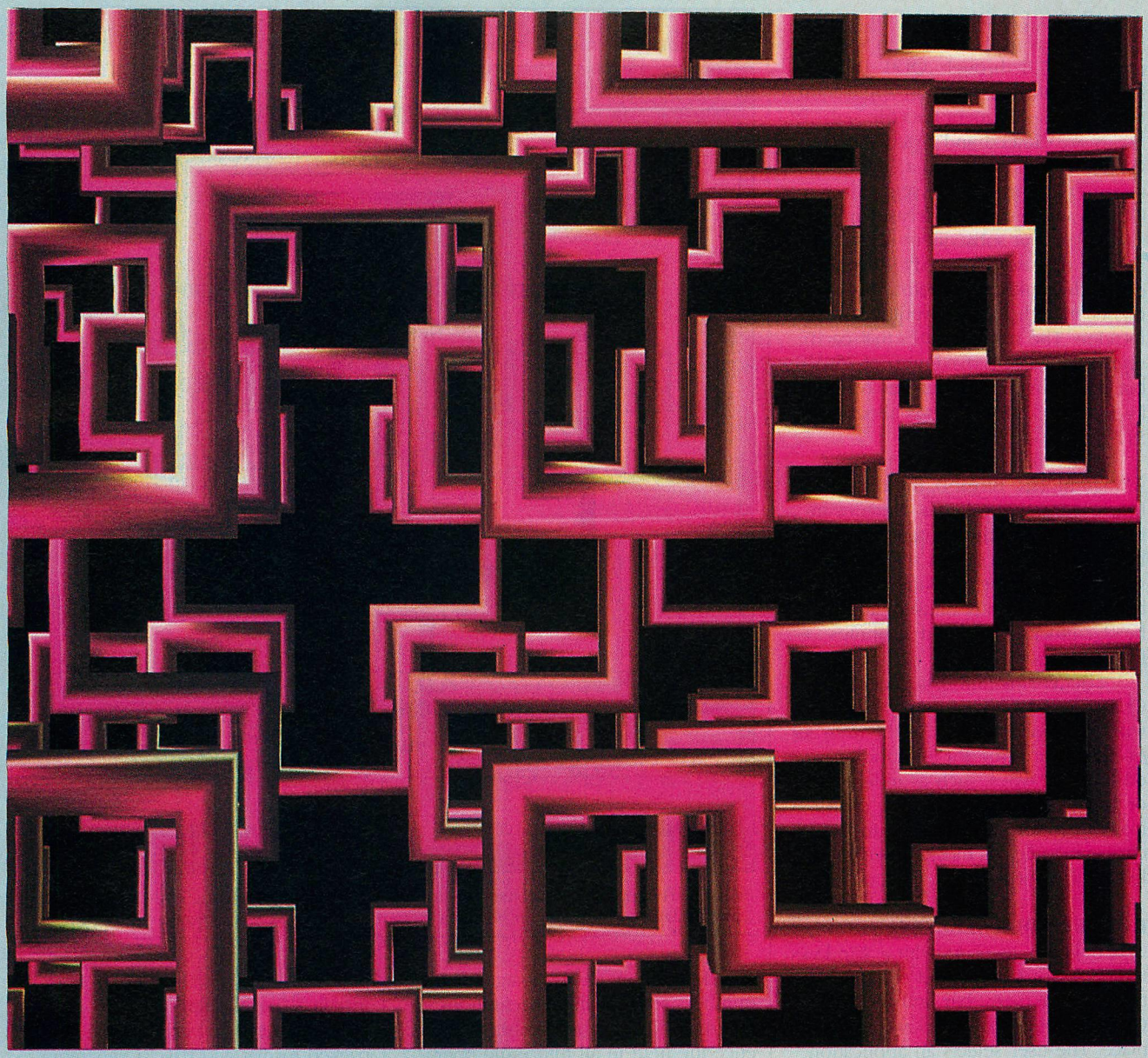
Quartz's innovative field types, such as check boxes, radio buttons, and push buttons, offer elegant solutions to processing problems that often require tedious programming in other database languages. End-user scrolling of list fields is also natural and consistent, even though the underlying list-management technology is awkward.

The graphics interface gives the developer freedom in report definition. Multiple fonts and WYSIWYG design are possible, with dimensions specified in inches or centimeters rather than columns and rows. The user can redirect reports to printer, screen, or file, with screen and printer output matching. (The sidebar on page 115 gives an overview of Omnis Quartz features.)

A mouse is not technically mandatory, but both Quartz and Windows are unacceptably cumbersome without one. Developing applications in Quartz for a non-mouse environment defeats the purpose of this product.

A HYBRID MODEL

Although Omnis claims that its data manager is based on the relational database model, Quartz is more of a hybrid. It does not use related values in common fields as in the relational model (see "Database Design Techniques," Dave Browning, July 1987, p. 112), nor does it use pointers to link files as in hierarchical and network



models (see "A Perspective on Data Models," Clyde W. Holsapple, July 1984, p. 113). Instead, Quartz uses system-assigned numbers, *record sequence numbers* (RSNs), to relate data tables.

Each RSN uniquely identifies a record, and Quartz assigns them sequentially for each file; they cannot be changed or reused (if the record is deleted). Quartz uses RSNs for retrieving records and relating data in multiple tables. Relationships must be predefined by setting connections for files. This is illustrated in the *PC Tech Journal* editorial inventory application. (For an explanation of this sample application, see "Evaluating Data Managers as Development Tools," Julie Anderson, August 1985, p. 46.) In the sample application, to relate the article file to the author file, Quartz places the RSN of the related author record into 1 of the 12 indexed fields of the article record. In Quartz terms, the article file is the child of, or is *connected for*, the author file (the parent). Each parent can have an unlimited number of child records, but each child can have only 12 parents, because each record has only 12 indexed fields.

For each index field, Quartz creates a table listing the RSNs of the child and parent records. Connections establish one-to-one, one-to-many, and many-to-many relationships. In a one-to-one relationship, either file can be the parent; in one-to-many, each parent has several child records—for example, an author with several articles. To create a many-to-many relationship, where each child can have several parents and each parent several children, Quartz sets up a *list file* as a connector or child for two tables being connected.

Although Quartz's database model is designed for fast retrievals, it does not permit easy database remodeling. Each file format is a template; changing any part of it—the number or lengths of fields, the data type, or the status (indexed or not) of a field—necessitates restructuring the database. This is performed via the Reorganize Data option on the utilities menu.

MOVING AND STORAGE

A Quartz application comprises data, data-description, and data-manipulation elements: file formats, to define the structure of data; layouts, to describe the display of data; menus, to provide an interface between the user and the data; reports, to define printouts; and searches, to select subsets of data (see figure 1 for the elements of Quartz applications). The data are stored in data files; other elements are stored in application files. The number of applications is essentially unlimited.

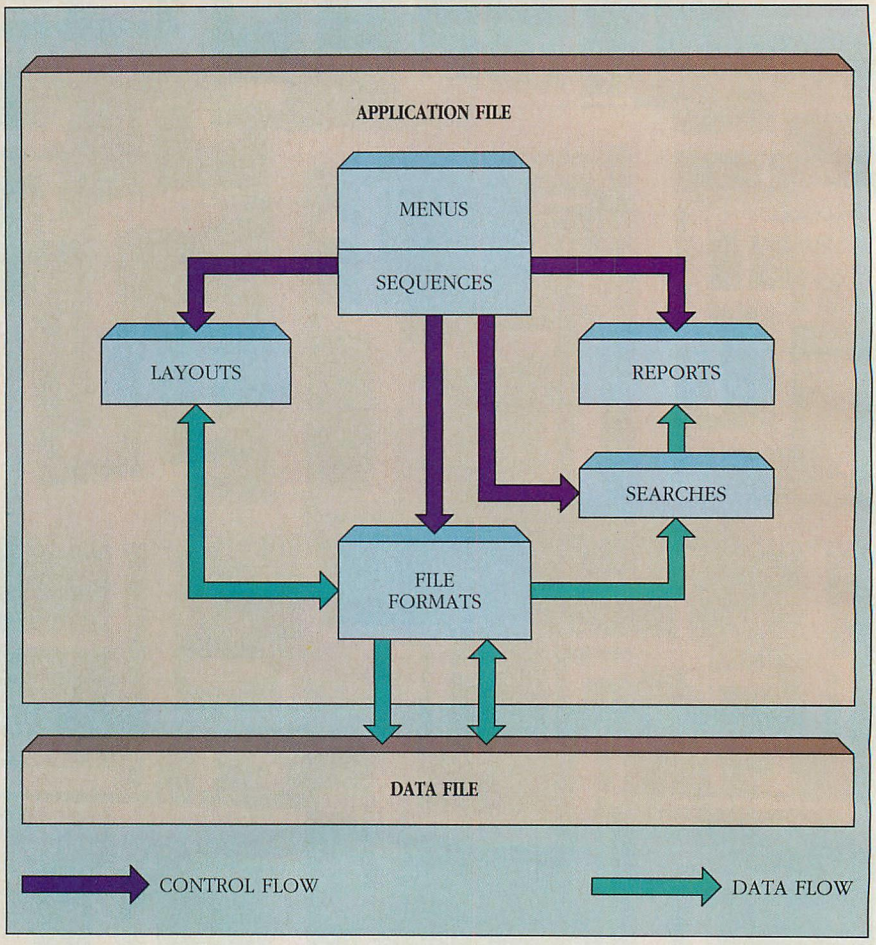
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All data for an application reside in a set of as many as 10 files with extensions .QD1 through .QD0. The .QD1 file is established when an application is created; subsequent data-file segments are created and space allocated via the utilities menu. In a single-user system, the first data-file segment (.QD1) automatically increases in size as needed, but subsequent segments require the user to specify space allocation. In multiuser systems, all segments, including .QD1, require preallocation. The manual states that each segment can be a maximum of 256MB, but not if this limit is further restricted by DOS to 32MB. Space is allocated in 512-byte blocks.

Data files contain five types of storage blocks. Block 0, the master block, stores critical data-structure information about the contents of a data file. Data blocks contain actual data, index blocks store the indexes, free blocks are currently unused, and file-header blocks store field attributes for data files.

Data chains link data blocks. Quartz keeps track of empty blocks with *free chains*. Blocks in the *data set free chain* are free for allocation as other block types, such as index, data, or header blocks; the *file free chain*, maintained for each data file in the database, indicates blocks freed by deletion of records.

FIGURE 1: *Structure of Omnis Quartz*



Adapted from Omnis Quartz Reference Manual, *Blyth Software, 1987.*

All Quartz applications consist of the Quartz program, the data, and five data-manipulation elements: file formats, layouts, reports, searches, and menus.

ROLL UP YOUR SLEEVES

Quartz greets its users with a Windows interface that has file and edit selections on the menu bar and the Select Quartz Application pull-down menu in place. The user selects an application from the menu or chooses Create New Application. An options selection then provides a pull-down menu for manipulating all elements of an application, including file formats, layouts, menus, reports, and searches. All of these elements are developed independently and are manipulated and stored as separate objects.

File formats. File formats, which contain field attributes, indexes, and sizes for fields, are stored in the application file, so one such file can be used with more than one data file. The developer can specify as many as 60 file formats for any one application, as long as the total data length (record length) of the combined file formats does not exceed 24,000 characters.

Each data-storage file holds a maximum of 120 fields. Each field has seven characteristics: number, name, type, length, decimal places, index flag, and description. Quartz assigns field numbers sequentially as definitions are entered and uses the numbers to reference the field in all future file operations. Thus, the developer can change field names without loss of data but should not move fields within the file format even if blank field definitions occur when fields are removed. These restrictions apply only after data have been entered. The developer can modify file-format definitions, as necessary, during design.

Field names have a maximum of 15 characters, beginning with a letter, and can incorporate special characters (except space). Field names must be unique within an application, not just within a file. Seven types of file-format fields are available: character, national, number, Boolean, date, time, and sequence. Character fields can be 2,400 bytes long and hold alphanumeric data; they are sorted in ASCII sequence. National fields are the same as character fields but are sorted according to an internal collating sequence that depends on the Quartz language version installed (usually English).

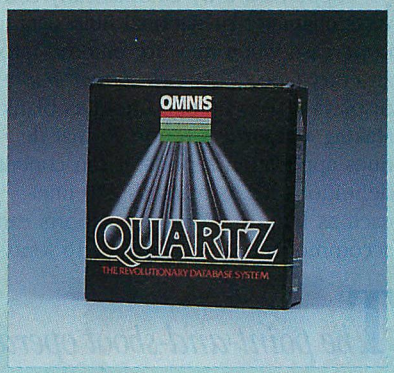
Number fields are stored in 6-byte, packed format and have a maximum precision of 11 significant figures with 6 decimal places. Quartz does not differentiate between integers and real numbers. Boolean fields occupy 1 byte each and store true/false values; these fields can be used in calculation formulas, with a numeric value of 1 for true and 0 for false.

Each of the two date-field types stores a 100-year range. The default Date (00) field stores dates in the range of January 1, 1900 to December 31, 1999; the Date (80) field range is from January 1, 1980 to December 31, 2079. Date fields occupy 2 bytes and are used to combine dates and numbers of days (date plus or minus number of days, and date minus date).

Time fields store time values of the form hh:mm in the range from 00:00 to 23:59 in 2 data bytes. Time fields can be converted to minutes (hh * 60 + mm) for calculations.

OMNIS QUARTZ OVERVIEW

OMNIS QUARTZ
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1065 E. Hillsdale Blvd., Suite 300
Foster City, CA 94404
415/571-0222
CIRCLE 335 ON READER SERVICE CARD



Product description. Quartz uses the Microsoft Windows 2.0 environment to provide a graphics user interface similar to that of the Omnis 3 Plus data manager for the Apple Macintosh. For users with Windows 2.0 or Windows/386 already installed, Quartz installs as an application under that system; for users without Windows 2.0, the Quartz package includes a copy of the Microsoft Windows 2.0 Single Application Environment (SAE).
IBM PC environment. Quartz runs on an IBM PC/AT or compatible or an IBM PS/2 Model 50, 60, or 80. It requires a CGA or EGA monitor adapter (an EGA color monitor is recommended), 640KB, a hard-disk drive, and Windows 2.0 or the Windows 2.0 SAE. A mouse is recommended.
Network support. Quartz is available for local area networks that support DOS. These include Novell's NetWare, IBM's PC Network, and 3Com's 3+.
Copy protection. None.
Documentation. Three manuals: *Learning Quartz*, *Applying Quartz*, and the *Reference Manual*.
User interface. Windows 2.0 interface.
Help facilities. No on-line help.
Capacities. An application file (application specifications and programs) can be a maximum of 2MB and contain as many as 240 individual formats of as much as 100KB each. As many as 60 files can be open at any one time. The maximum size of a data-file set (combination of as many as 10 data-file segments) is 2,560MB, with no limit to the number of records. A database can contain as many as 60 files. File formats each can have 12 indexes, 120 fields, 2,400 characters in a text or national field, 11 significant digits of numeric precision, and 12 connected files (each connected file requires an index); seven field types are available. Layouts can contain 12 windows each, with a maximum of 120 fields per window. As many as 12 layouts can be installed at one time, with a maximum of 12 open files per layout. Seven user-defined colors are available in any window.
Reporting. Reports can be 30-inches wide and 240-lines long. A single report can have as many as 1,200 fields and a maximum of 16 fonts; 9 sort levels and subtotal breaks can be specified. Multiline fields can expand to 80 lines each, and text fields can contain as many as 5,000 characters.
Data types. Quartz supports the following data types: character and national (a maximum of 2,400 alphanumeric characters); number (a maximum of 11 significant figures and 6 decimal places); Boolean (yes and no values); date—[Date (00), for years 1900 to 1999, and Date (80), the default, for 1980 to 2079]; time (stores as hh:mm from 00:00 to 23:59); and sequence. (Quartz assigns a sequential record sequence number or RSN to each record entered.)
Data entry. Data are entered via default of developer-designed window menus. Menus can contain a maximum of 100 program sequences, with as many as 120 commands per sequence (from 180 available). A menu can have 20 option choices, and as many as 12 menus can be installed at one time. A calculation expression can be as long as 240 characters, maximum menu size is 30KB, and no sequence can exceed 5KB.
Querying and sorting. Search formats can have as many as 50 lines.
Import/export. Quartz imports and exports from/to dBASE .dbf, Lotus .WKS, SYLK, .DIF, ASCII-delimited, and ASCII, one field per line.
Price. The stand-alone version of Quartz is $795; the network version is $1,495 for three users and $195 for each additional user.
Support. Blyth offers a free 60-day warranty and two types of extended support: the Continuing Support Program ($95 annually) includes a technical newsletter, direct telephone support, and automatic updates; the Comprehensive Support Program ($195 annually) includes all of the above plus a free data-utilities disk and training discounts.

—Dave Browning

A sequence field allows read-only access to the RSN. Quartz does not assign the RSN until entered data are committed for update, so the RSN cannot be used in calculations until after the record is stored.

Any field can be indexed. For character and national fields, specifying the index length limits index storage requirements. Only the first 75 characters of the field can be used for indexing. Calculation formulas cannot be used in index definitions, nor can multiple fields be combined for indexing.

A field description consisting of as many as 35 characters can be entered for documentation purposes. Quartz does not use this field characteristic; however, it nonetheless is printed with field definitions.

Laying it all out. A layout defines the user interface to the data. Quartz does not limit the number of layouts in an application but does limit the number of windows in each layout to 12. Each window can contain 120 data fields from a maximum of 12 files in the database. Layout windows contain fields for data entry, display, and manipulation. Rectangular outlines, in several thicknesses, with square or rounded corners, divide layout windows into regions.

Layout fields define the interaction between the user and the underlying data file within a layout window. Six types of layout fields are available: entry, display, check box, radio button, push button, and list.

Entry fields accept keyboard input for placement into a data file. Display fields are for output only and do not permit data entry. Check-box, radio-button, and push-button fields are for mouse data entry, although the keyboard also works. Check-box fields are clicked with the mouse to select or deselect an option. Radio buttons are groups of text fields associated with the same data-file field. Each radio button in the group sets the field to a different numeric value—0 for the first button, 1 for the second, and so on. A radio-button group might be used for the selection of Mr., Ms., Mrs., or Miss.

The user clicks on push-button fields to activate program sequences. A data form for entry/edit/view might contain push buttons labeled add, edit, find, next, previous, and quit. List fields present lists of data values in windows the user can scroll. For data entry, the developer can program a list field to let the user scroll through and click on a desired value that is then captured to another field. List fields are not scrolling views of data files, however; lists are built into memory before they are presented to the user, so the user cannot edit them, and they might not reflect the current state of the database in a multiuser environment.

Layout fields have attributes that control the processing of entered data. Color and invisibility attributes are available to all fields. Others are appropriate only to certain layout-field types.

Automatic find, which applies to entry and display fields only, can be used when the associated file-format field is indexed. With this attribute, user-entered data can be used to locate a record in a connected file through its index. This feature could, for example, locate a customer record when the user enters the customer code. If the program finds no matching record, it returns the first record with an index value greater than the requested value. *Exact match find* is the same as automatic find except that the sought-after value must match the field exactly.

Check calculation applies to entry fields and lets the user specify an expression of any combination of field names, constants, operators, and/or functions. Quartz evaluates the expression to validate the data value entered; invalid data cause Quartz to sound the bell, requiring the user to enter a correct value.

Justification applies to text or number fields; it can position the displayed value to the left, center, or right within the field boundaries.

Local attaches a display field to the first previous nonlocal field and forces the calculation of the expression whenever the value of the preceding field changes. This attribute is useful in presenting the look-up results of a customer name when an account number is entered. *Negatives allowed* permits or restricts the entry of negative values into number fields.

Show with border, which applies to entry and display fields only, produces a rectangular border around the field area. *Unique index check* prevents duplicate entries in indexed fields. This is done at data entry because Quartz indexes are not sensitive to the uniqueness of the indexed data.

Uppercase only automatically converts character or national field data to uppercase when they are entered into an entry-type field. *Zero shown empty* displays a zero numeric field as blank.

Making a report. A report format defines application reports; it can contain definitions for as many as 240 lines, each as long as 30 inches. Reports can accommodate a maximum of 16 fonts, depending on the installed printer. Report fields define the presentation of data in reports; the two basic report-field types are text and data.

The point-and-shoot operation of the Quartz report facility is much improved over those found in many other data managers.

Text fields conveniently present text within a report; they can combine normal, bold, italic, and underlined text in a single font and size. They can have multiple lines and can incorporate macro variable expansion (Quartz *square bracket notation*). Once entered, the text is word-wrapped automatically within the boundaries when text fields are moved or sized. A report text field can hold 5,000 characters.

Report data fields are similar to format and layout fields. In addition to using a field name from a format file, data fields can have internal variables, such as #D for current date, #P for page number, or other temporary internal variables. Also available is a no-name field type to place text on the report without using up internal-variable names. Field characteristics, such as number of decimal places, invisibility, calculation, and automatic find, apply to report fields as well as to format and layout fields.

Report fields can have additional attributes. The *totaled* attribute produces subtotals and totals; *duplicates blank* suppresses subsequent printing of repeated values; *no line if empty* suppresses the printing of blank lines; and *skip section if empty* allows conditional printing of report sections. Two numeric print-formatting attributes are available: *shown like (123.4)*, to print negative values in parentheses, and *shown like 1,234.5*, to print numbers with embedded commas. Report fields can be justified left, right, or center; font, size, and style are user's choice.

Missing from Quartz reports is a general field-formatting capability to embed special characters in strings, such as the dashes in social security numbers. The calculation attribute can define an expression of string-manipulation commands to do this kind of formatting, but this can be tedious and awkward. Also missing are floating dollar sign and other common business numeric formats.

Quartz reports offer a wealth of specification options. Report sections include heading, detail heading, detail section, nine levels of break subtotal sections, totals section, end-of-report section, and an auxiliary positioning section that permits the division of other sections into two or more subsections for positioning elements such as page headers and footers.

Report parameters can print the detail section in an export format, set margins in inches or centimeters, set spacing between successive detail sections, print a label report, set a repeat factor, and establish sort fields. Reports with the *label report* option checked can be specified further as to the number of labels across a page (one to six) and the width of the label. A repeat factor specifies the number of times a detail record is repeated for printing, a useful option when printing multiple copies of mailing labels.

The report *sort fields* option lets the user specify nine sort fields; each can be ascending or descending and/or converted to uppercase for sorting. The user also can mark fields to indicate that field value changes should trigger subtotal breaks. A *new page* trigger on field change can be specified.

Sort fields has only limited capability for sorting calculated virtual fields. In the sample application, one report required sorting on both issue volume and number fields. The volume field is a single-character field; issue number is a two-character field, with values between 1 and 12, right-justified with blank fill. No set of sort-field parameters enabled Quartz to sort this field combination properly.

The standard sort of the second field produced the sequence 1, 10, 11, 12, 2, 3, . . . , 9. The Quartz workaround for this problem is to define an internal data field on the first line of the report layout to be used as a sort field. An internal numeric field is computed to be equal to the offending

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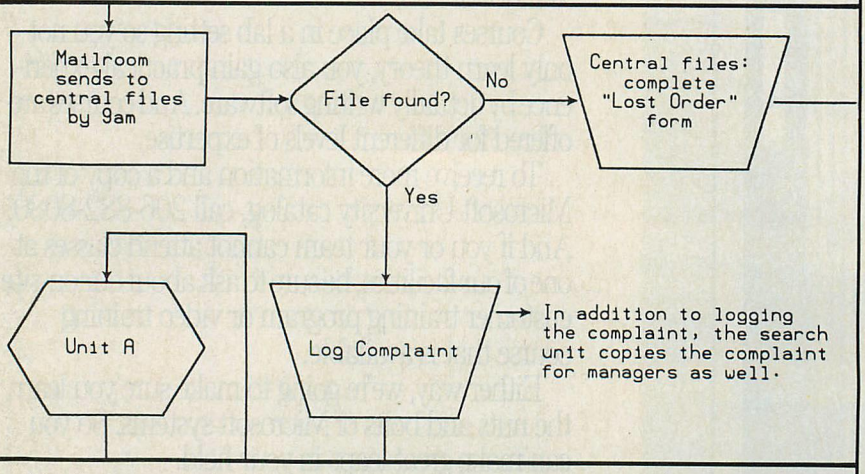
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character field, thus forcing a type conversion from character to numeric. Quartz allows only one of these internal sort fields per report, however, and gives no warning if a second field is defined and specified—the sort simply does not work. Combining two fields into one by calculation fails as well, as one of the subtotal break levels would be eliminated.

These difficulties not withstanding, the point-and-shoot, WYSIWYG operation of the Quartz report facility is a welcome relief from the antiquated report writers found in many other data managers.

Searching for records. Searches define selection criteria for retrieving records from files. The documentation does not state a limit for the number of searches that can be defined for an application.

A maximum of 50 lines of field comparisons is available for each search specification, and search lines can be comparisons, calculations, AND operators, or OR operators. A comparison search line compares a field value to a specified value using a comparison operator (greater-than-or-equal, less-than-or-equal, not-equal-to, equal-to, contains, or begins-with). A calculation search line permits the use of variable names, constants, operators, and functions to define an expression that evaluates to a logical true or false to cause the selection or rejection of the record being examined.

A search line can have an AND or an OR to specify how the preceding and subsequent lines are to be joined. These AND and OR lines break a multiline search into groups. Search lines within a group are sorted by field number, with calculation lines going to the bottom. In addition, consecutive search lines within a group are considered to be joined by AND, except where two consecutive lines have the same comparison field and a common comparison type of equal-to, begins-with, or contains.

Quartz makes no provision for grouping parentheses, so logical evaluation of a search of more than a few lines can become complex. Neither can Quartz handle situations that require parentheses to define the condition. The greater-than and less-than operators would be welcome additions.

Menus and sequences. Menus are the most powerful and complex objects in Quartz. A menu contains as many as 100 *sequences* (lists) of Quartz commands, numbered 0 to 99, that define the menu contents and the programs that can be executed by the menu

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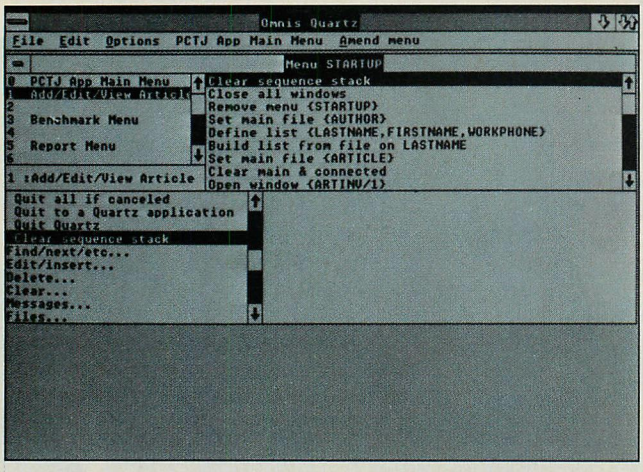


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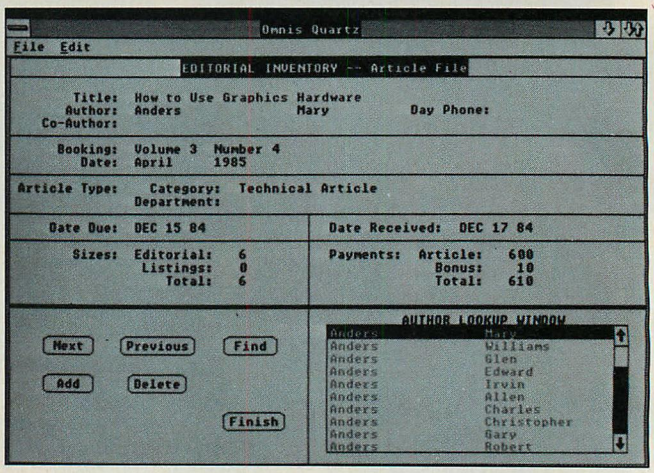
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PHOTO 1: *Programming STARTUP*



Entering a sequence is done most efficiently using a mouse to select the sequence line from the upper-left window (in this case, Add/Edit/View Article) and the commands from the scrollable list in the lower-right window. The sequence being built can be viewed in the upper-right window.

PHOTO 2: *Article-file Screen*



The data-entry screen for adding, editing, and viewing article records in the *PC Tech Journal* sample application provides an author look-up window and choices for manipulating records, including finding a record, viewing preceding and succeeding records, and adding and deleting records.

choices or by push-button fields in an associated layout format. Each sequence can contain as many as 120 commands, selected from a list of 180.

Photo 1 shows the four areas of a menu-definition window. In the upper-left corner is a scrolling list of the 100 possible sequence lines. The developer enters a description of the sequence into the line through the small box just below the scrolling window.

As each sequence is selected, the upper-right corner shows the scrolling-command list associated with the currently selected sequence line at top left. The lower-left corner contains a scrolling list of the 180 possible commands. Commands that are followed by ellipses indicate a header level that has detailed commands located one or two levels below it. The lower-right box can contain specific fields for the entry of parameters when required by a selected command.

To enter a sequence (that is, write a program), the developer scrolls to the desired line number in the sequence list and clicks on the line. A subsequent click on the data-entry line below the scroll box allows the developer to enter the sequence description from the keyboard. Next, the developer creates the command list by scrolling to a line and clicking on it, then selecting the desired command from the list of available commands at lower left.

As the commands scroll, the current command (highlighted in the lower-left box) also appears on the selected line of the command list being generated. Commands below a command header become available by double-clicking on the header. Finding a command under various levels can be difficult because the developer must click open each potential level and scroll through the list to view the items. Further, some commands are not grouped logically. When the developer finally selects a command, any required parameters are displayed in the lower-right box for data entry. Figure 2 shows some sample sequences in the sample application.

The first 20 sequences in a menu can be used for menu options. The description for the first sequence becomes the menu title; subsequent sequence descriptions become menu choices. A single blank sequence causes a dividing line to appear in the menu, and two blank sequence lines terminate the menu-choice section.

The command list associated with a menu-choice sequence executes when that choice is selected. User activity during data entry or calls from other sequences triggers the menu-choice sequence. The user defines menu sequences and command lists almost entirely via point-and-shoot of the mouse. This reduces typographical errors but it can become restrictive as the user gains increasing familiarity with the commands.

A user can trigger a sequence associated with a menu-choice during the operation of an application as well as during data entry. For example, a menu sequence can open a layout window and an associated data file and place the user in data-entry mode. When the user clicks on a push-button field, the sequence specified by number in the layout-field definition is executed.

Quartz allows the developer to alter the system's default data-entry activities with a control sequence. As the user moves from field to field during data entry, internal Quartz variables make available the field number, field name, mode of data entry, and a variety of other data. The control sequence can test for specific events, trap keystrokes and mouse clicks, and alter internal Quartz variables to change data-entry activities.

For example, skipping data-entry fields is sometimes preferable, depending on the answer to a question (such as skipping over the spouse-name field if a person is not married). The control sequence can determine that the user has completed entering data into a certain field, check the data entered, and then modify internal variables to tell the cursor to move to the next appropriate field.

Figure 2 shows the set of sequences and control sequences for the article-entry screen for the sample application. The first menu is called STARTUP (each application can have only one). Quartz automatically loads the application's STARTUP instead of the Quartz option menu when the user opens the application. Sequence 0 establishes the title for the menu (PCTJ App Main Menu) and opens the ARTICLE file. Sequences 1, 3, and 5 define options on the menu (sequences 2 and 4 are left blank to separate the listed options). Sequences

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Now grown to 400 functions Essential produces pop-up menus, save and restore screens and windows to disk or memory in as little as 1/10th second, and the fastest video output available. Library has a complete set of 50 business graphics functions, 40 string handlers, 28 functions for printers, 18 for mice, 11 for time and date. DOS interfacing functions offer disk error trapping, directory and file management. Everything in source, including sample programs that demo library functions. We have versions with pre-built libraries for all well-known C compilers, and a source code librarian is supplied for rolling your own.

	List:	PC Express
C Utility Library	**$185**	**$119**
Essential Graphics	**$299**	**$225**
Essential Communications with Breakout Debugger	**$185** **$250**	**$125** **$189**

C-TREE & R-TREE

B-Tree File Manager Now Has Report Generator

c-tree: The only major b-tree file manager with network support in the standard low-cost version. c-tree™ gives you record-locking routines for DOS 3.1/3.2, UNIX and XENIX, and it even comes in C source code, yet there are no royalties. Source sticks to K&R , so c-tree is portable. Tests in many environments prove it.

Permits any number of keys for a data file—alpha, numeric, even floating point. Handles files with varied record lengths, multiple keys in one index file. Both high level and decomposed functions. It's the works.

r-tree: Adds the ability to produce ad hoc reports from files maintained by c-tree (v. 4.1 and up). Link a file description to the r-tree™ library, and use any text editor to write report scripts with no further C coding. Reports can access data in several files, select on criteria, join findings into new logical records, sort them, calculate new fields and columns, tabulate by control breaks. Comes in source, same portability as c-tree, and fits any compiler.

	List:	Ours:	Combined:
c-tree:	**$395**	**$299**	**$499**
r-tree:	**$295**	**$235**	

WINDOWS for DATA

M'soft Windows Compatible

"Onlt one package can be easily recommended" said *Computer Language* (June '87) reviewing nine window and data entry products for C. Complete field level functions specify prompt string, field length, data type, screen location, picture, target variable, entry rules, help messages, even functions to call for validation once data keyed in.

Windows for C is a subset. No data entry but all windowing functions. Unlimited windows can be made either to pop up or permanently overwrite the screen, scroll and highlight lists vertically and horizontally. Specify Compiler. Windows for Data: List **$295**, Ours **$259**. Windows for C: List **$195**, Ours **$149**.

BLAISE C TOOLS PLUS/5.0

C TOOLS PLUS/5.0 from Blaise Computing Inc. helps you to quickly build professional applications using the full power of Microsoft C 5.0 and QuickC. Now you can concentrate on program creativity by having full control over DOS, menus, interrupt service routines, memory resident programs, fast direct video access; windows; printer and keyboard control, and more!

Blaise Computing's attention to detail, like the use of full function prototyping, cleanly organized header files, and a comprehensive, fully-indexed manual, makes C TOOLS PLUS/5.0 the choice for experienced developers as well as newcomers to C.

C TOOLS PLUS/5.0 prebuilt libraries are ready to use with either QuickC or the Microsoft C 5.0 command line environment. Complete documented source code is included so that you can study and adapt it to your specific needs.

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Turbo POWER TOOLS	**$ 99**	**$ 75**
Turbo ASYNCH PLUS	**$ 99**	**$ 75**

PANEL PLUS

Library Source Code Gives It Complete Portability

There are no end of tools for screen design and data entry, but none quite like Panel Plus. Design a screen under program control, use Panel's utility to "run" and test it field by field, then pass it to Panel's code generator which delivers C source code. Options style the code to your compiler's liking, and you can of course do what you like to the source afterward. The code calls Panel Plus's function library, but now *the library comes in source,* so everything produced is highly portable. Not like other screen managers delivered as object libraries and which leave *you* to write the detailed code.

Panel Plus will operate in graphics mode via interfaces to graphics products it supports and can utilize the EGA's 43-line screen. Low-level I/O functions adapt it to various keyboards, screens, operating systems.

Panel's newest incarnation has every imaginable feature. A single screen design can have 1000 fields stacked as visual overlays up to 127 levels deep or as pop-ups. Groups of fields can be moved between levels. Screens can be output as compilable code or stored on disk for loading at run-time. Each field can be boxed, colored, multi-row, word-wrapped, and scrolled horizontally and vertically if larger than its on-screen view aperture. It can be assigned its own help and error message, can be told to accept certain characters, or to match a picture, and to check data after entry—proper dates, number ranges, etc.—using Panel's or your own validation routines. You can add your routines to Panel's test utility because even it comes as source. Fields are accessed in any order and control reverts to your application program after each field for choice of action.

For past Panelists, the new version has smaller and faster field and screen functions, tighter granularity, and an enhanced, reworked library. Major tool for the serious developer. List: **$495**, PC Express: **$395**.

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Source Code Control for Any Language

PVCS allows programmers, project managers, librarians and system administrators to control the proliferation of revisions and versions of source code in software systems. Independent programmers, the leading software publishers and LAN companies, and hundreds of Fortune 1000 companies rely on PVCS to store and retrieve multiple revisions of text. It maintains a complete history of revisions as an "audit trail", generates status reports, and uses intelligent "difference detection" to minimize disk space for each new version.

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Corporate PVCS is for multiple programmers. It includes "branching" to maintain code when programs evolve on multiple paths. Personal PVCS offers most of the power and flexibility of corporate PVCS, but excludes multiple programmer features. Network PVCS is the Corporate version for LANs. File locking and security levels can be tailored to each project.

Ask for:	List	PC Brand:
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Corporate PVCS	**$395**	**$329**
Network PVCS	**Call**	**Call**
PolyMake	**$149**	**$129**

dBC *Identical dBASE III Plus Files Using C*

dBC™ is a series of C libraries from Lattice which creates, accesses and updates files identical to those of dBASE itself. So dBASE can read and update the files too.

What for? It means both C and dBASE applications can operate on the same data bases interchangably. It means C programmers can interface with the big market of dBASE users out there, yet side-step the dBASE language. It means dBASE applications can now be linked to the universe of C libraries and tools to add windows, graphics, statistical analysis, all the things dBASE cannot do. It means the speed and power of C to impress clients accustomed to dBASE!

dBC's functions parallel all dBASE's file handling commands, many decomposed to permit direct data manipulation. Our versions of dBC mimic file formats for dBASE II and III and now dBASE III Plus makes your programs network ready!... as many stations as a network allows. Hands-off mode handles record and file locking and unlocking automatically. Close in functions give you direct lock/unlock control.

Supports all four memory models. dBASE II, III...List: **$250**, Ours: **$175**. dBASE III Plus...List: **$750**, Ours: **$595**. Call for Source Code Pricing.

C-WORTHY INTERFACE LIBRARY

The C-Worthy™ Interface Library wraps an entire user interface around your application. Its full power can be summoned by only a few high level calls. Sound exaggerated? A single function call can set up a complete text editor in a screen window. Recently acquired by Solution System, over 600 pages of Documentation, Turbo and Quick C version and a complete Interface Library have been added.

- High level calls pop menus and scrollable choice lists to the screen, restoring the background when dismissed.
- Windowing facilities open portholes of up to screen size for viewing virtual screens larger than the physical screen.
- Full context-sensitive help screen management takes over these chores and error messages. Automatic routines interrupt with pageable text windows explaining what to do next.

Novell found it "played a key role and accelerated development" in making its NetWare™ utilities easier for users. Ingenious demo: call for it.

Ask for:	List:	PC Express:
C-Worthy	**$195**	**$159**
with Forms Library	**$295**	**$269**

THE SPINDRIFT LIBRARY

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Spindrift's smooth package offers something previously unavailable to the Fortran buffs...a basket of functions, packed to the brim. No more tedious coding. Just call on Spindrift with it's armoury of functions.

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You dBASE™ programmers know what an expressive and readable language dBASE is. It's a very comfortable development environment. But the price is debased performance. Even compiled dBASE doesn't offer the speed that some users require these days. The kind of speed offered by software written in the C language. The answer is dBx™

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The Power Environment for dBASE Programming

Many worthy utility products supply needs that dBASE®'s programming language doesn't—dUTIL™, dFLOW™ and a host of others. Trouble is, you have to use them separately, then combine their output into your dBASE program files.

No longer. dBRIEF™, written in BRIEF's macro language, grabs hold of BRIEF and turns it into a complete dBASE III and III Plus programming domain. Using BRIEF's underlying shell capabilities and its own interfaces, dBRIEF can run external utility libraries, plus dBASE itself, and link to the Clipper™, Foxbase+™ and Quicksilver compilers, all with dBRIEF still loaded and running the show. It can do what BRIEF already does plus:

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- Create databases; index files; invoke Ashton-Tate's dFORMAT™ and dCONVERT™; draw lines and boxes.

"Simply marvelous programming environment for writing and editing dBASE programs.", *PC Magazine*, 7/86. Source code included!

Requires BRIEF 1.32 or later and 384k; 512k to run dBASE within dBRIEF; 640k and harddisk recommended.

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The Complete dBASE Companion

Who says you can't have it all?

APPLICATIONS PLUS has *everything* you need to get the most out of dBASE: An application generator (QUICKCODE PLUS), relational report writer (QUICKREPORT), and graphics system (dGRAPH).

QUICKCODE PLUS offers *dozens* of features you've *never* seen before in a dBASE code generator. Relational applications that read, display, and update a dozen or more databases simultaneously. "Real-time" calculations, performed *on screen* as the user enters each field. Forms up to 11 screens long, with the ability to pass data between screens. Computational formulas that automatically combine data from *different* databases. 9 Data types. 16 field types.

QUICKREPORT is a full-featured relational report writer, which combines up to 6 databases in one report, handles many-to-one relations, fancy printer features (like **bold** and *italics*), computed fields, and up to 16 levels of totalling and sorting.

dGRAPH is a graphics system that produces bar, pie, line, and piebar charts directly from dBASE data. Dozens of options let you tailor graphs to your needs.

APPLICATIONS PLUS is 100% compatible with Clipper and FoxBASE+.

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MICROSOFT LANGUAGES

Powerful Implementations Of The Most Popular Programming Languages

Microsoft C 5.0: The flagship of the Microsoft line runs up to 30 percent faster than its predecessor. Its new optimization features deliver untouchable execution speeds, 100 new additional library routines...

Microsoft MacroASSEMBLER 5.0: If you ever wanted to take on the challenge of assembly, here's your opportunity. "MASM" 5.0 is a lot easier to use, has completely revised documentation, and a new "Mixed Language" programming guide that gives you step by step instructions for linking your assembly code with other Microsoft languages.

Microsoft QuickBASIC 4.0: is a revolutionary concept in BASIC programming. It allows you to run, edit, debug, and run again. Our friends at Microsoft have eliminated the dreaded compile step. Whenever you edit your code QB4 automatically incorporates your changes, so that it can run a program of 150,000 lines in less than a minute.

Each member of this language family includes the renowned debugger CODEVIEW.

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Microsoft C	**$450**	**$295**
Microsoft Macro-ASSEMBLER	**$150**	**$109**
Microsoft QuickBASIC	**$ 99**	**$ 66**
Microsoft FORTRAN	**$450**	**$295**

NOVELL: BTRIEVE, XQL, XTRIEVE

Sophisticated Tools Essential For Fast Database Handling

Btrieve is a library of subroutines that allows the programmer to build a database application using any language. It takes complete charge of all file creation, indexing, reading, writing, insertion, deletion, forward and backward searching. Its balanced tree indexing scheme finds any key in a million in less than 4 accesses...That's fast!

Btrieve is multi-lingual also. It includes more than 20 language interfaces (including C, BASIC, PASCAL, FORTRAN). However if it turns out that you are using something a little unusual, worry not. The manual includes a chapter on how to write a language interface to Btrieve.

Btrieve's vital statistics are equally impressive. Files may have up to 24 indexes; fixed record length to 4090 characters; variable length to 64K; indexes to 255 characters; files of 4 billion bytes. Network support includes Novell, 3-COM, IBM PC NET, Software Link's Multilink and many others.

XQL is a relational database management system designed especially for programmers. Imagine being able to access your database with the ease of SQL (Structured Query Language) statements and still having the power to process that data right down to the byte level.

Think about your applications. A large part of your software development effort is probably devoted to managing data stored in files on disk. Hours spent writing lines of code to search and store data records could have been used to program more important parts of your application. Why not let XQL do it for you. XQL will increase your programming productivity and let you focus on building better applications.

The XQL system works in tandem with Btrieve and has an equally powerful chassis...No limit on the number of records per file. Max. file size is 4 gigabytes, Max. record size equals 4K, Max. indexes per file is 24. The one version works for single or multiuser systems, DOS Ver 3.0 or greater. All languages are supported.

Xtrieve is the final ingredient in the Novell programming recipe. It is a menu driven, data retrieval system, that allows you to quickly find information and display reports. System developers can easily customize Xtrieve to display command menus, help files, and error messages in the English spoken by the customer. Xtrieve screens then gives menu choices that users can quickly recognize, making Xtrieve an easy product to use and understand.

Report Option for printing customized reports, form letters, mailing labels & statements.

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Btrieve	**$245**	**$175**
Btrieve/N	**$595**	**$445**
XQL	**$795**	**$595**
Xtrieve	**$245**	**$220**
Xtrieve/N	**$595**	**$459**
Report Option	**$145**	**$128**
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For serious applications stick to the tools that stick to the standards. Not the least of reasons why GSS™ has emerged as the pre-eminent graphics toolmaker is that it has always conformed to ANSI standards.

At the heart of the system is the CGI standard Development Toolkit. It has all language interfaces and device drivers for keyboards, mice, joysticks, tablets, printers, plotters, cameras. The drivers completely insulate your application from concern for device idiosyncracy.

GSS Kernel™ conforms to ANSI's GKS 2b and has all its drivers and language bindings. Macro level tools to draw, color, segment, transform, store and recreate an object. The Metafile Interpreter reads ANSI CGM files with full CGI capability for recreation on various devices.

Quality software? IBM thinks so. They sell GSS under their own label. Royalties.

Needs 256k.	List:	Ours:
CGI Dvlpment Toolkit	**$495**	**$425**
Kernel System	**$495**	**$425**
Kernel for IBM RT	**$795**	**$645**
Metafile Interpreter	**$295**	**$265**

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FIGURE 2: *Sample Sequences in Sample Application*

```
-------------------------------------------
SEQUENCES FOR STARTUP AS AT JUN 21 88 (15:26)
      PAGE 1
-------------------------------------------

0 PCTJ App Main Menu
--------------------
Set main file {ARTICLE}

1 Add/Edit/View Articles
------------------------
Clear sequence stack
Close all windows
Remove menu {BMARKS}
Set main file {AUTHOR}
Define list {LASTNAME,FIRSTNAME,WORKPHONE}
Build list from file on LASTNAME
Set main file {ARTICLE}
Clear main & connected
Open window {ARTINV/1}

3 Benchmark Menu
----------------
Clear sequence stack
Install menu {BMARKS}

5 Report Menu
-------------

10 Finish Add/Edit
------------------
Clear main & connected
Close window {ARTINV/1}

11 Delete Article
-----------------
Yes/No message (Large size,Sound bell)
  {Delete this record - Are you sure?}
If flag true
  Delete
  Clear main & connected
  Redraw windows
End If

12 Add Article
--------------
Set control sequence 13 {Control for Add Article}
Repeat
  Clear main & connected
  Calculate #1 as 0
  Prepare for Insert
  Redraw windows
  Enter data
  If flag true
    Update files
  End If
Until flag false
Clear main & connected
Redraw windows

13 Control for Add Article
--------------------------
If ((#EN='AAUTLN')|
  (#EN='AAUTFN'))&((#EM=1)|(#EM=2))
  Calculate #1 as 1
Else If ((#EN='ACOAUTLN')|
  (#EN='ACOAUTFN'))&((#EM=1)|(#EM=2))
  Calculate #1 as 2
End If
If (#EM=5)&(#EF=29)&(#1=1)
  Set current list 1
  Load from list
  Calculate AAUTLN as LASTNAME
  Calculate AAUTFN as FIRSTNAME
  Calculate #S5 as WORKPHONE
  Redraw numbered fields 2 to 4
  Calculate #ER as 1005
  Calculate #1 as 0
Else If (#EM=5)&(#EF=29)&(#1=2)
  Set current list 1
  Load from list
  Calculate ACOAUTLN as LASTNAME
  Calculate ACOAUTFN as FIRSTNAME
  Redraw numbered fields 5 to 6
  Calculate #ER as 1007
  Calculate #1 as 0
Else If (#EM=5)&(#EF=29)&(#1=0)
  Calculate #ER as 0
End If

14 Get Deadline Date
--------------------
No errors found.
  4% of available sequence space is in use.
```

Each menu in Quartz is composed of a series of Quartz commands collectively called a sequence. The start-up menu for the sample application is composed of 14 sequences; sequences 1, 3, and 5 define menu options. Subordinate code to sequence 1 produces the article file data-manipulation screen; subordinate code to sequence 3 provides another menu. Sequences 12 and 13 are for adding records.

3 and 5 illustrate chaining a subordinate menu to a main-menu choice.

Sequence 1 (triggered by the user selecting the first menu choice) initializes files and menus and builds a list of last names, first names, and work telephone numbers from the author file. The article file and the article-inventory layout window are then opened. Push buttons in the window let the user move through the file record-by-record by selecting Next or Previous. These push buttons execute standard predefined Quartz sequences (numbers in the range 100 to 110) to position the data file.

If the user chooses the Add push button, sequence 12 executes, thus activating the data-entry control sequence 13 and entering an add-data loop. The Enter Data command turns data-entry control over to the user, but sequence 13 continues to monitor user activity. The first line of sequence 13 checks to see if the user is in the author last- or first-name field. If this is the case, an internal flag (internal variable #1) is set to show which fields (author or coauthor) are intended to be filled from the scrolling author list. This internal flag is necessary because the same author list is used for both author and coauthor data entry.

When the user selects a name from the scrolling author list (field 29), the internal data-entry mode flag (#EM) is set to 5, indicating that the user has double-clicked on a list-field row. After checking to see if the user is selecting an author or a coauthor (temporary variable #1), the sequence executes a Load From List command. This command sets the current values of the LASTNAME, FIRSTNAME, and WORKPHONE buffers to the selected values from the list. The article-file fields (AAUTLN, AAUTFN, and a temporary telephone number display variable, #5) then are calculated, and the data are displayed with Redraw Fields. Setting the #ER variable to 1005 forces the cursor to the next data-entry field.

Quartz's capabilities for data-entry process control are more flexible and efficient than those of many procedural data-manager languages, but they have some limitations. For example, the use of list fields to capture data into more than one layout field requires some awkward constructs, and the control-sequence technique requires substantial effort to construct a set of condition statements that trap exactly the desired data-entry situations.

One major weakness in Quartz data entry results from its list-management implementation. The fact that a memory-resident table of fields selected from a data file must be generated for presentation to the user negates one of the common uses of list techniques. First, the size of the list that can be created is limited, so many data files cannot be fully captured. The process of building a list based on a filter condition (that is, the first letter of the last name) would be prohibitively slow within a data-entry screen—the user would have to wait while the program generates a list of all records that meet specific criteria.

In addition, the list technique cannot be used to search a file for an entry and select it if it is there, or to add a new entry to the file if it is not (a common situation in data entry to a multiple file database).

The Quartz menu implementation is powerful but complex. The technical approach to control of data entry is sophisticated and flexible, but it may require much trial and error to master. Learning the programming skills necessary to create menu-sequence programs takes time, and program debugging is difficult due to a lack of tools.

MANAGING THE SAMPLE

The *PC Tech Journal* sample application centers around a data-entry screen for magazine articles (see photo 2, p. 120) that contains requirements for

INTENSE COMPETITION HAS A WAY OF BRINGING OUT THE BEST.



In the computer industry, manufacturers fight to make their machines faster, friendlier, and more powerful than everybody else's. But as you may have noticed, the most successful competitors build their systems around the same chip: Intel's 386™ microprocessor.

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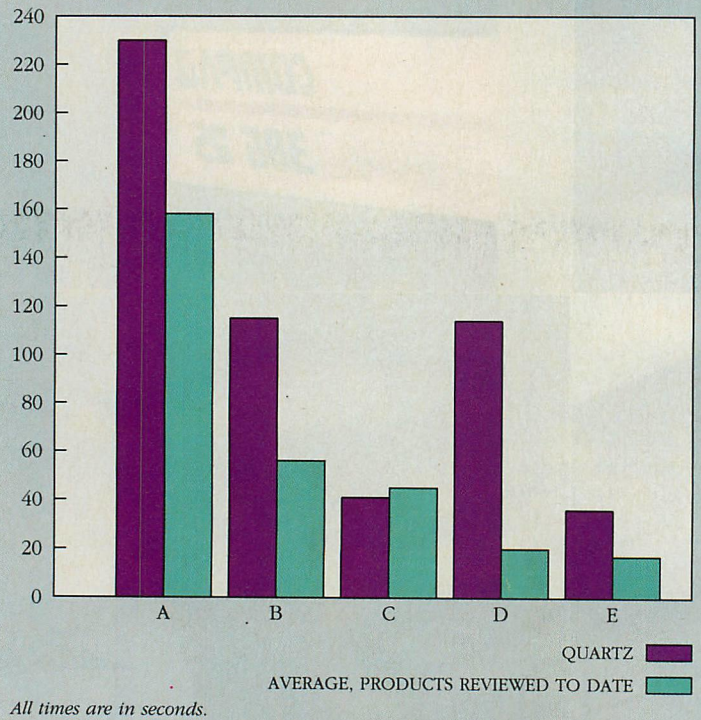
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FIGURE 3: ***Benchmark Results***

BENCHMARK TASK	TIME
A. Add 900 records to an empty database table	230
B. Index table on two fields (7 bytes)	115
C. Document and tally codes from one column	41
D. Mass change of one column (28 rows of 900)	114
E. Extract selected records to create a text file	36



All times are in seconds.

All benchmarks were run on an IBM PC/AT (6 MHz) with 640KB memory. The tests were run in an 8MB partition on a CMI 20MB hard disk under DOS 3.0.

Omnis Quartz was a considerably slower in performing the benchmarks than the average of all data managers tested to date—except in the third benchmark.

look-up searches from a separate file of authors, conditional fields, and calculated fields. Several problems were apparent in implementing the sample application in Omnis Quartz.

The most noteworthy difficulty is in searching a file on two field values simultaneously. When an article is entered, the application specifies that the author's last and first names should be entered and these values used to locate the author's telephone number from the author file. Quartz, like many other data managers, does not provide for multifield or virtual-field indexes, so no means are available to search the author file on a combination of the last-name and first-name fields, unless they are combined in a separate field when the author file is designed.

To illustrate the Quartz list-field feature, the sample application was modified to let the data-entry user select the appropriate author from a scrolling list of the author file. Because lists must be generated in memory before they are presented on the data-entry screen, using the same list for selection into two different field groups causes complications. If the application specification were to require the ability to add an author at time of article entry, additional programming and regeneration of the list would be required. Because of a lack of ad hoc query capabilities in Quartz, the specified queries must be implemented by programming, a reasonably straightforward process.

Another Quartz inconvenience is the inability to sort on a function of a field. Instead, Quartz permits sorting on a single virtual field that is specified on the first line of a report. This workaround is a step beyond the capabilities of some other data managers; it would be better still if it were not limited to a single virtual-sort field.

On the other hand, Quartz easily manages the difficult task of combining department- and category-field data entry, where valid entries in the category field depend on the current value of the department field. Many data managers cannot accommodate this requirement without programming, and others cannot implement it at all. The calculated fields for editorial and listing page totals are straightforward.

Because of the restrictions in multifield look-up, Quartz had difficulty with the article deadline date, which should be retrieved from an issue file based on the combination of volume and issue numbers. Quartz offers two ways to do this. In the first, a sequence program can locate the appropriate issue file record. In the second, the volume and issue numbers in the issue file are combined into one field—a more appropriate solution for this and other data managers.

The data model followed by Quartz creates one difficulty itself. The linkage (a Quartz *file connection*) between article and author files requires that the author-file RSNs be stored in the article-file records. If the author file is connected so that the article file can establish a one-author-to-many-article relationship, then the data-entry process automatically stores the linking author RSNs in the article-file records as they are entered. If the author and article files are loaded through the import facility, however, the linking RSNs are not established automatically.

The developer would have to write a program to force record-by-record processing to establish these linkages, and the other problem of finding an author in the author file based on a combination of last-name and first-name fields would then interfere as well. This problem does not arise in a relational database because the relationship is established at retrieval, based on equivalence of key fields rather than on fixed linkages embedded in file records.

Quartz was put through the five benchmark tasks developed for *PC Tech Journal*'s data-manager reviews. While it is not the slowest data manager tested to date, it is far from the fastest (see figure 3). The results show that it was much slower than the average of those tested in this series in all but the third benchmark.

END-USER FEATURES

The installation and support logistics for Quartz are in keeping with the complex nature of the product.

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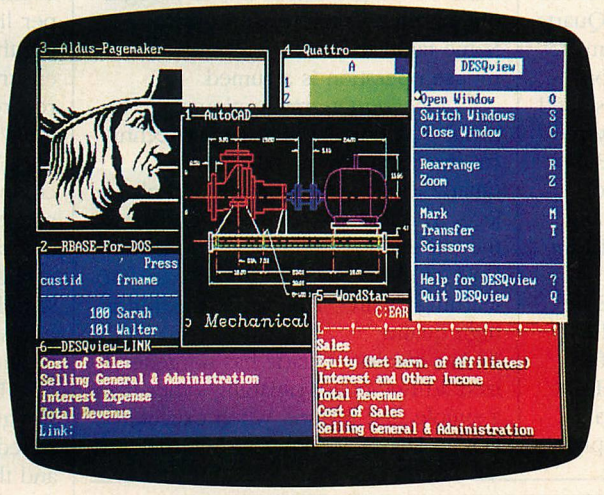
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Installation. Quartz is shipped with two sets of installation diskettes—a set of four high-density 5.25-inch diskettes and a set of six 3.5-inch diskettes. Users with PC/AT-class machines that have only 360KB diskette drives will encounter some difficulty installing Quartz and the included Windows Single Application Environment (SAE). If the package diskettes are converted on another machine to 360KB diskettes, the files will not be in the expected locations for the SAE setup program.

If sufficient hard-disk space is available (about 900KB for Quartz and 2.4MB for the SAE set-up diskettes), the user can temporarily copy the diskettes to a hard-disk directory and run Quartz INSTALL and Windows SETUP from there to install the system. The converted Quartz diskettes can be installed first, then the temporary directory reused for the Windows diskettes. Following installation, the Quartz programs, example application files, and Windows SAE take up about 1.8MB in the Quartz directory.

The SAE requires that SHARE be run before Windows is started. The Windows INSTALL program modifies AUTOEXEC.BAT to include the SHARE statement. Windows also has specific requirements for RAM-disk drive programs if they are used and includes a RAM-disk driver. (INSTALL provides information on this subject.)

Documentation. The Quartz documentation includes three manuals, each of which has a table of contents and index and is divided into sections; each section has its own table of contents as well. The tutorial, *Learning Quartz*, introduces Quartz sequences (programs) and describes planning an application; creating file formats, layouts, and data files; entering and manipulating records; producing reports; and customizing menus. Blyth provides several user exercises in sample Quartz applications. The organization is well-thought-out, and the examples appropriate. Some familiarity with Windows and mouse operation is assumed.

Applying Quartz continues the tutorial environment at a deeper technical level and covers more of the Quartz theory of operations and objects. The *Reference Manual* provides the expected in-depth technical detail. Both of these manuals are necessary to learning Quartz. The documentation is high quality.

Ad hoc queries. Quartz has no generalized ad hoc query capability other than a simple find feature. When executed from a layout window, the internal find sequence allows the user to enter a value for one of the indexed fields. The program in turn displays a record that matches the specified value. If no record matches that value, the first record with the indexed field's value greater than that requested is displayed. The user can construct specific queries by developing search objects, which act as filters on the file and restrict access to records that meet the condition, or by programming sequences for calculated and multifield searches.

Import/export. Quartz imports from and exports files to dBASE, .dbf, Lotus .WKS, SYLK, .DIF, ASCII-delimited (with commas or tabs), and ASCII, one field per line. Loading connected files during the import process requires care to ensure the creation of proper interfile record links. Files with no connections must be imported before connected files. The import-data records must include a unique index value for the connected file so that the correct record can be located in it and the connection RSN field updated. For the sample application, this technique did not work because of the dual-field key requirement.

The process of importing is straightforward: the source file is selected, the target main file is specified, and the target fields are selected from the file-format field list. The import process can insert new records into the main file, or the first main-file field can be an indexed field, and the import process can be used to update records matching this key field.

Data export is essentially the same as import. When exporting connected files, a unique indexed field must be included in the field list for each connected file so the records can be joined during the export process.

Security measures. Quartz offers flexible security-control features. A master user can assign multilevel passwords to users. Menu options, including the standard Quartz menu options as well as application-specific options, can be protected on a user-level basis. The user level is also available as an internal variable to sequence programs, so that users can be prohibited from initiating processes even if they do not appear on a menu. Further security is provided by application locking and file-format protection.

Another system protects the application from users who do not know a specified password. Once an application is completed, it also can be locked so that it cannot be modified by anyone, including the master user. Once



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locked, an application cannot be unlocked, so copying and archiving an application is essential before locking. A locked application must have a menu named STARTUP; otherwise, there is no way to access the application.

In addition to locking the application, which prevents the application processes from being modified, a protect option is available to protect individual file formats from modification.

WINDOWS-STYLE DEVELOPMENT

The Everex System 1800 used in the research for this article locked up four or five times during the process. It was not obvious whether the problem was with the Quartz code or with the Windows SAE. The lock-ups could not be duplicated (for the purposes of further investigation) with reasonable effort. The 6-MHz IBM PC/AT, however, had no problems when running the standard benchmark tests.

The Video Seven VEGA Deluxe EGA installed in the System 1800 includes a screen-save utility that blanked the Quartz/Windows screen after a period of keyboard inactivity; the Quartz/Windows keyboard handler would not pass any keystrokes to the screen-save utility to restore the screen. After the first occurrence of this problem, the utility was disabled.

Quartz is not an end-user development system for databases more complicated than single-file list management. With no built-in default record screens or scrolling browse windows, a file format and a layout window (at a minimum) must be defined before data can be entered and reviewed. Without programming, the user must make a short but necessary sequence of menu selections to open the data-file and layout-window objects before reviewing data. In many other data managers, these capabilities are built-in or are available via automatic application-generation tools.

The accurate, efficient linking of multiple database files to a custom Quartz application requires sophisticated professional development experience. The learning curve for Quartz programming is relatively steep—substantial effort is required to get the first program working, and debugging is a trial-and-error process. On the other hand, once learned, point-and-shoot programming for menu sequences is straightforward, but even this soon becomes a bottleneck because of mouse movement and the amount of clicking required to select a command from a list.

The multiuser features of Quartz were not tested. The Quartz documentation suggests that multiuser operation is "automatic," although it does not describe locking strategies or other multiuser considerations. Quartz provides no specific functions or commands for file, record, or object locking. The documentation states that the unique index-check attribute "is not so reliable with multiuser versions of Quartz." This is a welcome warning to unwary developers, but this kind of message undermines confidence in Quartz as a fully operational multiuser data manager.

Quartz maintains a data dictionary of sorts but does not label it as such. When the developer needs to select a field name, such as during layout window design, a menu choice or a function key opens a window that lists all format files, along with a symbol for the internal variable list. Choosing a format name opens a scrolling list of field names, and a double click on a field name selects it for the operation at hand. The field attributes (such as its type, size, and if indexed or not) should be displayed along with the field name to avoid having to set aside the current operation for a quick trip to the file format to check a field attribute.

Difficulties notwithstanding, Omnis Quartz delivers valuable technology that is not found elsewhere in the PC data-manager arena at this time. It is worthy of examination for its fine use of the Windows/mouse environment, and it incorporates good techniques for data-entry process control. Furthermore, version 2.0, which is due for release at about the time this article is published, will use the Windows Dynamic Data Exchange (DDE) protocol to allow Quartz to share data with other applications. (For a description of DDE, see "Windows of Opportunity.")

The steep learning curve for Quartz programming makes it unsuitable for end-user application development, and professional developers may find its data-management limitations too restrictive for general application development. Quartz would be an excellent candidate for some specific applications in which the need for a graphics user interface with mouse support is strong, and where its database-management limitations would be acceptable.

Dave Browning is a contributing editor to PC Tech Journal. *He is vice-president of WBS and Associates Inc., a microcomputer and database consulting firm.*

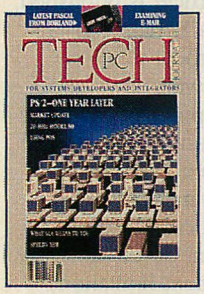


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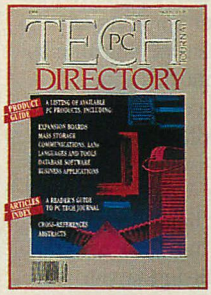
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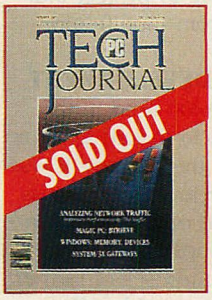
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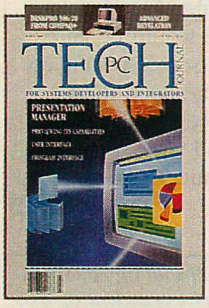
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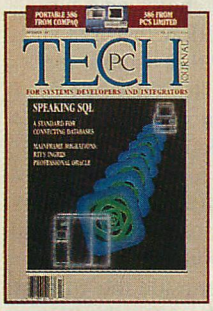
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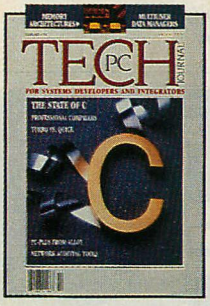
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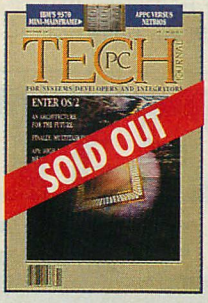
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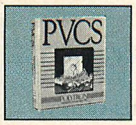
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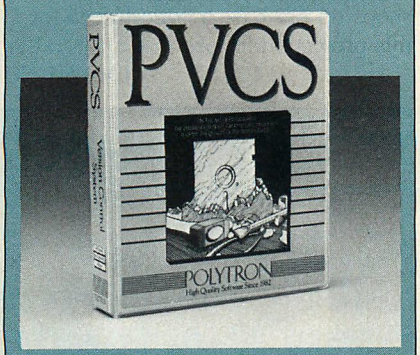
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A source-code-management system (SCMS) is a tool used by a programming team to track changes to source-code modules or other files. The SCMS regulates access to the source code, allowing programmers to spend time designing and debugging code rather than handling routine housekeeping chores (such as controlling the editing of a module to prevent simultaneous modification and remembering which revision of each module is used to rebuild a previous release when checking a bug report). An SCMS also reduces the amount of data stored by maintaining a base revision and storing only the minimum amount of information necessary to recreate all revisions of the file.

This review describes features added to the Polytron Version Control System (PVCS) with the release of version 2.0. The most important improvement is a menu-driven screen interface; the performance, however, is essentially the same (see table 1, p. 133). Only a few source-code management features have been added, which is not surprising since PVCS is one of the more full-featured systems. As this review went to press, Polytron issued an intermediate release (version 2.1), which fixes minor bugs.

Installation of PVCS is as easy as copying all of the files from the three distribution disks (two for the base system and a new one for the screen interface) onto a hard disk. A new supplement to the *PVCS User's Manual* describes the new screen interface. Several pages of the original manual were updated to reflect the changes to the base system. (For a complete description of SCMS and a review of six systems that run on DOS machines, see "Tracking Code Modules," Jim Vallino, September 1987, p. 50.)

SCREEN INTERFACE

The PVCS menu-driven screen interface displays options along the top line of the screen. The user selects an option either by entering the first letter of the option or by using the cursor to highlight the choice and pressing enter. Below the menu line is a description line that displays sub-menu options or describes a PVCS function.

The top-level menu items are Configuration, Logfile, Revision, Display, Execute, Version, Alias, and Help. Each refers to different aspects of using the PVCS functions in order to manage source code. When an option is selected, either sub-menu options will appear on the menu line or the options for the selected function will appear in the workspace below the menu. The Esc key always returns the user to the previous menu.

On-line help is available by pressing the F1 key, which displays a help window at the bottom of the screen; Alt-F1 enlarges the window to fill the entire screen. The Esc key returns the user to menu operation from either normal or enlarged help windows.

The developer can choose the color of each screen field (that is, the menu list, workspace, or help window) by using the Color option in the configuration file. Unfortunately, the user must repeatedly enter and exit the screen interface to test new color schemes. Moreover, the user cannot save the current configuration in a file for later use; options must be entered manually into the configuration file. (The color schemes cannot be changed from within the interface—an inconvenience.) The interface was tested on a CGA system.

Because of delays in screen updates to prevent snow when using a CGA, the performance is very slow (as is noted in the READ.ME file on the distribution disk). On a 4.77-MHz IBM PC, some of the screens used to specify options for PVCS commands take as long as 4 seconds to appear once the function had been selected. The editing of input, such as filenames, lags keyboard input by several characters.

Each function screen contains all the available options for executing that particular PVCS function. The user first fills in the entries for the options or uses the defaults provided, and then types "Y" next to the "OK to proceed" menu item or presses the F10 key. The "OK to proceed" item does not appear in the same place on every function screen and is used as a delimiter between the required fields and optional fields. The user must provide values for every field above "OK to proceed," while those fields below are optional. This often leads to searching for the field in order to enter "Y" and execute the function. A fixed place for the proceed and cancel fields, with some other mechanism used to distinguish required from optional fields, would be more logical.

The output generated by the selected function appears in the workspace window; the interface optionally

allows for pausing after each windowful of output has been displayed. Command-line parameters, taken from the data provided by the user on the function screens, are either used on the command line of the PVCS function (when it is executed) or are placed into a command file read by the function. The command line is written to the directory specified by the WORKDIR configuration option or, if it is not specified, the TMP environment variable. The latter feature is not documented in the manuals, but is detected easily when the command-file location is specified on the function command line. The current directory is the default location.

After a function is executed, the menu reverts back to the top-level menu. This is inconvenient since a user often repeats the same action on several files with slightly different options. If a mistake is made in entering a file name, for example, the user must traverse the menus again to correct it. All menus, except the top-level menu, remember the last option used. The top-level menu is always displayed with the first option highlighted after a function has been executed. Fields on function screens retain their previous values when the screen is displayed.

This system allows for aliases to be defined for use when specifying lists of file names. All DOS environment variables are considered to be aliases. The user also can define the aliases in the configuration file or by way of the Alias function of the screen interface (which also allows aliases to be displayed, edited, and deleted).

On several of the menus, the file-name field is limited to 40 characters. The system will not accept more characters than this, which can cause a problem if the full path name for a file is greater than 40. The interface should allow for the specification of file names up to the 64-character maximum allowed by DOS.

Because the PVCS menu system is large (requiring over 200KB of RAM), it deeply cuts into the memory available to run other DOS commands from the Execute function. The Execute function does not provide a method to spawn a new DOS shell automatically. A common approach similar programs use is to execute the command specified by the user or, if none is entered, spawn a new copy of COMMAND.COM. The PVCS screen interface does not do this, requiring the user to enter a command to be executed instead.

NEW FEATURES

A few new source-code-management features have been added to PVCS. In the previous release, deletions of revisions from an archive file were performed using the VCS command. Now, a user deletes a revision or group of revisions with the new VDEL command. A source-code librarian can control the deletion of source revisions by restricting the use of the VDEL command.

A symbolic version label can be assigned to a branch of a logfile, not just to a particular revision on that branch. Anytime a user checks out a file specifying the branch version name, the latest revision of the file on the branch associated with that name will be retrieved.

This feature is similar to providing a symbolic name for a branch of module development. It would be useful, however, to specify a symbolic name for revisions on the branch independent of the branch version label so that a user could specify the "BETA release of the OS/2 branch" rather than only the "latest revision of the OS/2 branch." To do this, a standard version label containing all of the symbolic information—"OS_2_BETA", for example—must be assigned to the appropriate revision of the source file.

Aliases can be defined and used for lists of file names. All DOS environment variables automatically become aliases, and, in addition, the user can define other aliases in the configuration file used by the PVCS commands. The user references an alias on the command line using the syntax **$(alias-name)** or **${alias-name}**.

To use aliases from the command line, it usually is necessary to preface all command-line arguments with the special −C option. This option forces the default configuration file to be processed with any alias definitions, and it also causes the environment variables to become accessible as aliases. If the alias definitions have not yet been processed, then, in most places where an alias is used, the alias is expanded to a null string. The definition of an alias in the configuration file takes precedence over environment variable definitions if an alias name appears in both places.

It is now possible to place comments that describe the workfile or specify the reasons for the changes into a separate file, which the **Put** command reads when checking in a file. This feature can be used with the −T@[file] or −M@[file] options of the **Put** command where [file] is the name of the file which contains the description. The file-name extension for this file can be calculated in a manner similar to the calculation for archive extension from workfile extension. The configuration option, MESSAGESUFFIX, specifies this calculation in the same way that LOGSUFFIX specifies the workfile to logfile calculation.

Polytron's PVCS 2.0 remains a strong SCMS based on features in previous versions. While possibly welcomed by novices, the screen interface in version 2.0 does not enhance what PVCS does best—managing source code. The user interface is similar to those found in other SCMSs, and it probably will not influence a purchase decision in either direction.

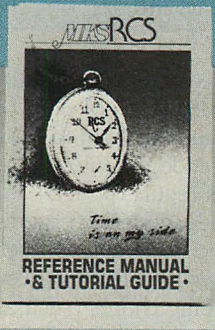
The only feature that PVCS still lacks is password protection on the archive files, but this is not a major omission because most programming shops do not have a critical need for this protection feature.

—JIM VALLINO

MKS RCS 4.2c

Mortice Kern Systems Inc.
35 King Street North
Waterloo, Ontario, CD N2J 2W9
800/265-2797; 519/884-2251

PRICE: $189



CIRCLE 337 ON READER SERVICE CARD

The original revision control system (RCS) was written for the UNIX operating system by Walter F. Tichy of Purdue University. The UNIX RCS has the same functionality as the Source-Code Control System (SCCS), which also originated with UNIX, and greatly increases speed of operation using reverse deltas to store revisions. The reverse-delta technique stores a complete copy of the latest revision of a file and the delta information necessary to recreate all previous revisions. Retrieving the latest version of a file (which is the most common

TABLE 1: *SCMS Performance*

	MKS RCS	POLYTRON VCS	OTHER SCMSs
TEST 1 FILE SIZE[a]	13,691	9,785	5,760–41,449
Get 1.1	47.7	9.8	1.8–70.0
Get 1.101	5.8	6.0	1.8–11.4
TEST 2 FILE SIZE[b]	2,134	1,785	1,599–2,709
Get 1.1	4.6	2.2	1.6–5.2
Get 1.2	3.6	2.2	1.5–5.4
TEST 3 FILE SIZE[c]	47,483	47,370	46,198–49,741
Put 1.2 (min:sec)	0:45	0:41	0:19–5:29

Tests were run on an IBM PC with 640KB RAM and a Maynard Electronics 30-MB Apollo disk. All file sizes in bytes; times in seconds except where indicated.

[a] *Test 1 created 100 revisions by adding one line at the end of the file for each new revision.*
[b] *Test 2 is a 50-line C program that had each pair of lines transposed to create revision 1.2.*
[c] *Test 3 is a file that contains 47,073 characters on 1,473 lines in the middle of which 21 characters were added to create revision 1.2.*

Compared with other SCMSs previously tested, MKS RCS is a middle-of-the-road performer on all tests; Polytron's VCS has similar performance numbers.

operation) is fast compared with retrieving older revisions that require several deltas.

The MKS RCS 4.2c from Mortice Kern Systems, a licensed derivative of the UNIX implementation, is a source-code management system (SCMS) that faithfully mimics UNIX RCS in the DOS environment. Those familiar with UNIX RCS can use MKS RCS immediately because the two have only a few minor differences between them (necessitated by differences between the two operating systems themselves).

The major difference between MKS RCS and UNIX RCS is the file-naming and file-storing conventions. Filename limitations in DOS prevent the approach used in UNIX. An archive file under MKS RCS control is given the same name as its work file, thus requiring the two files to be stored in separate directories. RCS stores archive files in a subdirectory (called RCS) of the work-file directory. The archive files on UNIX have the suffix ",v" and can be stored either in the work directory or in the RCS subdirectory.

In a network setting, it may be more desirable to check out (retrieve) a file into a load directory from a central network directory. RCS provides for this possibility with an RCSDIR option in the configuration file. Archive files are stored, by default, with the DOS read-only attribute on. The developer can disable this protection feature by selecting the NoWriteProtect option in a configuration file.

By using the MKS RCS co command to check out a file revision, the user can lock the file with the −l option on the command line. User identification comes from the LOGNAME option in the configuration file or a LOGNAME environment variable. If NETWORK = NOVELL is specified in the configuration file, the nework login ID will be made the user name.

When an archive is created with the StrictLocks option, the read-only attribute is set on work files checked out

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without a lock, reinforcing the fact that the file is not available for editing. If a writable copy of the work file exists when the checkout is requested, the user receives a warning message to approve the overwriting of the file.

The ci program performs the check-in operation after the user modifies a program module. If StrictLocks is set on the archive file, then the team member performing the check in must own a lock on the archive for the operation to be allowed, otherwise the check in is aborted. The ci program prompts the user for a file description when a new archive is created and for log information whenever a new revision to an existing file is made. These comments can be multiline, but once a carriage return is entered, the previous line cannot be edited. Unfortunately, MKS RCS does not permit the developer to access a text editor, as some other RCS packages do. RCS deletes the work file when the check in is completed, unless the developer uses the **-l** or **-u** command-line options, which cause the check in to be immediately followed by a checkout with locking (**-l**) or without locking (**-u**).

Revisions are numbered by default starting at 1.1 and each new revision increments the second, or minor, revision number. Subsequent revisions would be numbered 1.2, 1.3, and so on. At check in, for example, the user can force the revision number to begin a new major revision. MKS RCS allows an unlimited number of file revisions. When a revision number is used as a command-line argument, the developer can assign symbolic names to the revisions in an archive.

MKS RCS permits branches (parallel development paths off the main trunk of a module) to any depth. When a revision other than the tip of the main trunk or branch is checked out for editing, MKS RCS assumes that a new branch is to be created from this new file revision when the user subsequently performs a check in. This is accomplished by adding another pair of major/minor revision numbers (such as 1.2.1.1) branched from revision 1.2.

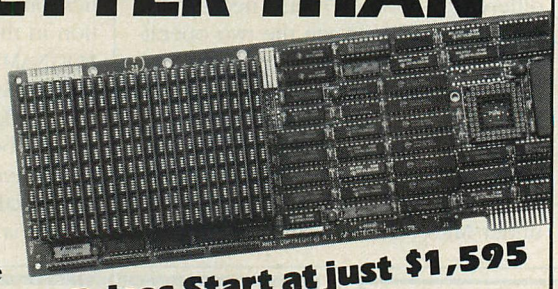
Other supplementary MKS RCS programs help with source-code maintenance. The rcs program performs various administrative functions on the archive files. These functions include revision locking and unlocking, access-list modification, and symbolic name manipulation. Revisions in an archive file also can be outdated (deleted) with the **rcs** command. The user can delete any file revision including a range of intermediate revisions.

The access list (login IDs) specifies who may have access to the archive file and what operations they can perform. The rlog program displays information about each revision, including log comments, a list of locked revisions and owners, and symbolic revision labels. The user can specify command parameters in order to restrict the display to subsets of the information that describes an archive file.

MKS RCS provides a full set of key words—including Header, Author, Date, and Log—that enable information about the particular revision extracted into a work file to be displayed in that file. RCS leaves the key words intact in the work file so that once placed into the file, the co program will expand the appropriate text every time a revision is checked out. The developer can place a key word, such as Header, into a work file so that the expanded key word text is compiled into the resultant

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object file. The **ident** command scans the object or executable file and displays its identification.

MKS RCS also includes a full set of difference and merge programs. The diff and diff3 programs create a listing of differences between disk files, and rcsdiff determines differences between a work file and a revision in any archive, or between two revisions in an archive. The user can output the differences in an edit script readable by the MKS RCS editor, ed. This allows the creation of a new file revision from the previous revision and edit script. The merge and rcsmerge programs combine two files that have a common base into a single revision. RCS flags conflicting changes in the merged file for manual processing.

MKS RCS ran without errors during testing and its performance is average compared to other systems (see table 1). MKS archive files are compatible with UNIX RCS except for two minor difficulties. First, when an archive file was transferred from DOS to UNIX, all RCS operations on that particular implementation would not work because the Access statement was expected on the second line of the archive file. MKS RCS, however, places a Branch statement in this location. When this statement was deleted (which made the Access statement the second line in the file), the UNIX RCS functions executed correctly. The archive file was then transferred back to DOS after several RCS operations were performed on the UNIX system. MKS RCS worked without the missing Branch statement and correctly retrieved the file revisions created on UNIX.

The second incompatibility surfaced with the AddCR configuration option and the difference in line separators between DOS and UNIX. If AddCR is not selected in DOS, multiline revision comments are expanded in the work file using only newlines (ASCII character 10) as the line separator. Thus, the retrieved revision is not properly displayed in most editors. For proper DOS operation, AddCR must be used in conjunction with the Log key word. When the user selects AddCR, a multiline comment in an archive file transferred from a UNIX system is retrieved with a blank line between each comment line.

MKS RCS faithfully duplicates the features of UNIX RCS in DOS and is a mature SCMS that provides all the basic features needed for multiprogrammer development projects. For UNIX programmers beginning work on a DOS system, MKS RCS will be welcome. With only minor problems, MKS RCS allows the programmer to move archive files between the DOS and UNIX environments.

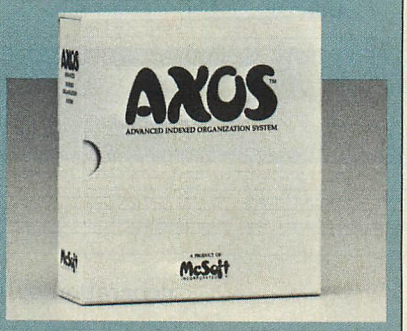
The major strength of MKS RCS—its strict compatibility with UNIX RCS—also could be its biggest shortcoming. Because it precisely reproduces UNIX RCS, MKS RCS does not have all of the features found in other, newer systems—most notably, PC network capabilities and the option of using an outside editor to enter revision comments. For many UNIX RCS users, however, MKS RCS's ease of use will outweigh the absence of these features.

—JIM VALLINO

AXOS 3.3

McSoft Inc.
P.O. Box 12044
Atlanta, GA 30355-2044
404/237-4169

PRICE: $595



CIRCLE 338 ON READER SERVICE CARD

The Advanced Indexed Organization System (AXOS) version 3.3 from McSoft is a data-file management system for the developer who does not wish to use a data manager. The possible reasons for shying away from data managers are numerous: the overhead may limit the amount of RAM available to the application, the lack of a compiler may impose too great a penalty in speed of execution, the application may require unavailable functions, or the developer may be more comfortable working in a general-purpose programming language. AXOS addresses these points and others, not the least of which is speed.

The heart of AXOS is a file processor attached to the operating system through the LOADAXOS program. Once loaded, AXOS can be turned off and on, but it remains resident and uses 77KB of RAM from the user-program area. Activating AXOS removes additional RAM for page buffers, which are used to minimize disk activity. The default page buffer is 5KB, but virtually the entire user-program area can be set aside. Deactivating AXOS reclaims the page buffers but not the 77KB of RAM. Once loaded and activated, any program that places values in CPU registers, executes DOS INT 21H, and reads values from CPU registers can call AXOS's 57 file-management functions.

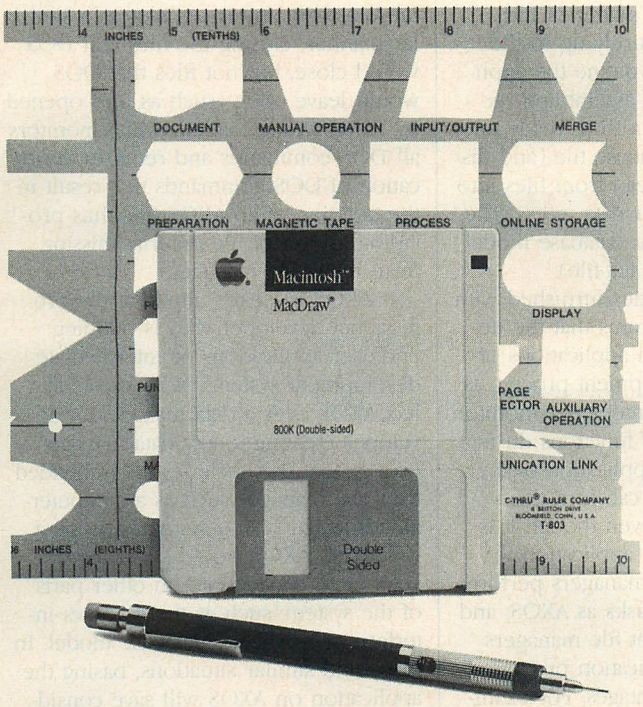
Three intermediate processors (furnished in assembly-language source code and object-file form) together with a generic AXOS programming language interface (in a 3,584-byte library file) ease the task of building AXOS applications. The intermediate processors include Microsoft C, Realia COBOL, and one for all other languages (Microsoft 8088 Assembly Language, COBOL, FORTRAN, and Pascal). A special interface is included for interpreted BASIC. The manual describes the structure of an intermediate processor, so the developer can write one. The package also includes example applications written in these languages.

AXOS has the file- and record-management facilities associated with high-end data manager packages, such as password protection, multilevel function security, audit trails, begin and end transactions, file conversion, automatic file recovery, and record encryption and compression. An AXOS application can create and maintain three types of data files—sequential, indexed, and index cluster—that use a three-level, binary-tree index structure. Applications can use all three types of files simultaneously. The developer can convert files of one type to another type with the XUTILITY program.

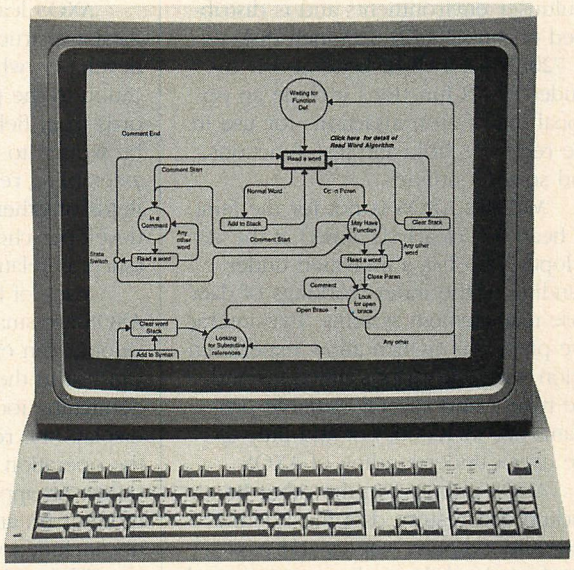
Sequential files are accessed via record number—a four-byte binary number. Indexed files are accessed via a unique key, which can be up to 240 bytes long. Index cluster files can have up to 64 different keys (or index paths), each of which can be up to 240 bytes for unique keys or 236 bytes for nonunique keys. (Nonunique keys typically are supplemented with the record number to create a unique key.) In every case, keys and data are maintained in the same file.

The file-indexing system allows each type of file to store as many as 16,777,216 variable-length records, which can be up to 64,000 bytes long. Files are limited in size only by the operating system (the package permits files up to 4,200MB long). Although

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AXOS encrypts and compresses all files, they can be accessed by any AXOS application written in any language.

AXOS operates in either single- or multiuser environments and is distributed on one 360KB 5.25-inch diskette (a 720KB 3.5-inch diskette also is included). LAN functions include an optional log of all transactions for use in file recovery, hold-and-free functions, and security utilities.

McSoft's AXOS is not for the faint of heart—it clearly is aimed at the developer who has a thorough understanding of the inner workings of database management systems. Two interactive programs (which allow experimentation with the various functions and file types), and several example programs are included, but add little to the user's understanding of AXOS.

AXOS utilities, on the other hand, backup and restore data files, define and edit computer names and passwords, control the audit processor and the transaction-logging facility, recover held records, list the contents of data files, and compact .EXE files.

One particularly useful program, the XCONVERT utility, converts other data files to AXOS files, building keys in the process. It converts files containing fixed-length records, variable-length records separated by control characters or preceded by a length field, and unloaded Btrieve files.

AXOS leaves the matter of the database structure entirely up to the developer, who must define the application to the point of assembling records from fields into a form ready to be written to the database file (and disassembling records read from files into fields or other smaller data units). The developer chooses the database model (such as relational or flat-file).

Many of the utilities furnished with AXOS are small programs that the developer can embed in applications or can use in the development process as debugging tools. An interactive monitor displays the results of functions during the operation of an application or a utility. An application can turn this monitor on and off, even though it is not included with the application.

While other file managers perform essentially the same tasks as AXOS, and other memory-resident file managers can be called by application programs, AXOS has some advantages. For example, AXOS provides 57 functions, including audit trail and key-only file management functions, and 64 index paths versus Btrieve's 31 operations and 24 access paths (file-size and record-length limitations are identical).

AXOS monitors the operating system's activity and treats files in a similar manner, closing the files that DOS would close, but not files that DOS would leave open (such as files opened by TSRs). While loaded, AXOS monitors all DOS commands and requires verification of DOS commands that result in the deletion of an AXOS file, thus providing a level of file security missing from many file managers.

AXOS is clearly aimed at the professional developer who is building end-user applications or intermediate development systems. Who would select AXOS over a data manager? A developer creating a new data manager, or a system that includes an embedded database manager such as a computer-aided design (CAD) system, may be a candidate. AXOS would allow the developer to concentrate on other parts of the system, such as the graphics interface or the actual database model. In these and similar situations, basing the application on AXOS will save considerable development time without sacrificing performance or database security.

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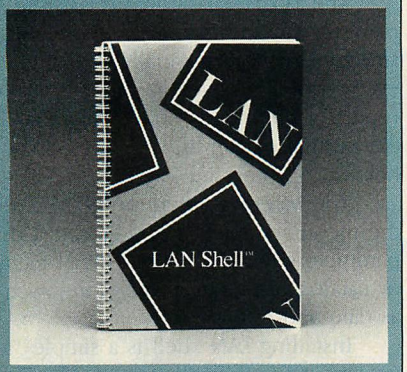
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The days of the stand-alone, two-function (spreadsheet and word processor) PC for business are disappearing fast. As corporations continue to buy more PCs, build departmental local area networks (LANs), and bridge these LANs together, the trend is clear—maneuvering through the corporate computer environment will only become more complex.

As more applications become available on networks, it will be increasingly difficult for the average user to navigate the myriad file-server names, directories, and drive mappings. The need for flexible and friendly menus and application front-ends has never been greater than it is now.

One way to help rein in the corporate network chaos is the LAN Shell 2.0 by LAN Systems. Available in both network and stand-alone versions, it provides the LAN manager with the tools necessary to create flexible, friendly, and fast menus. LAN Shell is one of the more function- and feature-rich network menu systems.

LAN Systems also sells, installs, and maintains LANs—and this is reflected in the product's design, which was driven by end users and network managers working in real-world network environments.

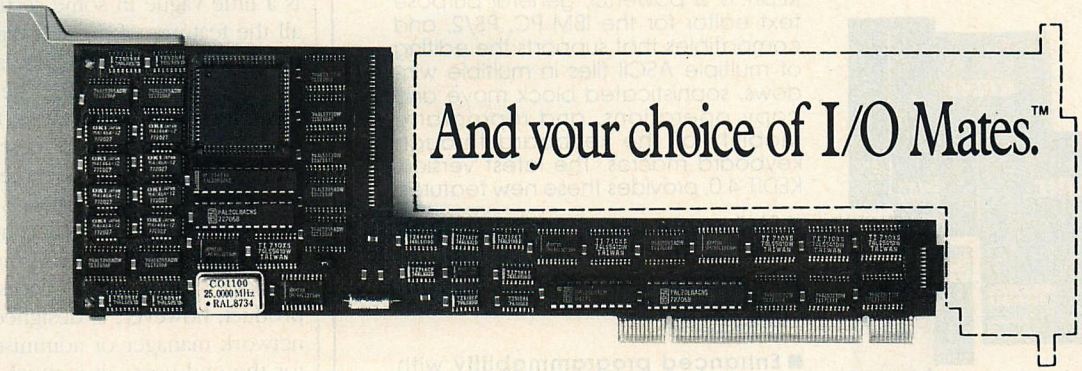
LAN Shell's newest feature, software metering, allows the network administrator to control the number of users accessing a particular application at one time to comply with software licenses. When the predetermined number has been reached, the shell prohibits additional access, and signals users to try again later. The PROGRAMS utility, included with LAN Shell, allows the network administrator to maintain a list of metered software packages and the number of licensed copies.

Other features that make the product worthy of consideration include its flexible screen painter, strong full-screen-editing capability, block cut/copy/paste commands, flexible pop-up help screens, and its ability to screen user inputs for legal values.

With the Shell Design utility, the network manager can design, test, and debug menu applications. It has a full-screen painter, an interactive debugger, and permits the designer to cut/copy/paste and frame any combination of ASCII characters and text.

The program has a wide range of options including bold, single-, or double-line borders; shading with special graphics characters; text justification; and the selection of foreground and background colors. Virtually any part of the screen can be highlighted, colored, boxed, or used as a pop-up help area. The user can position prompts anywhere on the screen, allowing a complete dialog capability.

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Once menu options are defined, the designer can optionally call programs, batch files, specially created forms, or even other menus. Several commands can be stacked and executed one after another. During the execution of a task or menu option, LAN Shell's overhead is quite small—only about 8KB—if directly calling a .COM or .EXE file. If calling a .BAT file or performing an operation where the command processor is invoked, LAN Shell's overhead is about 3KB more.

Network managers will welcome this economy of RAM because many already struggle with the large memory requirements of device drivers in the CONFIG.SYS file, network shells, and terminate-and-stay-resident programs.

In addition, the developer can set up temporary environment variables that automatically reset once the action of menu selection is complete. This gives the menu designer many options for controlling what happens after a user selects a menu option. The developer also can set passwords on individual menu items.

Menu options can carry special one-line messages (displayed at the bottom of the screen on line 25). Full help screens also are available as pop-up menus when the user presses the F1 key. The help screens can incorporate extensive text files using the WINOUT program. In fact, the developer could design a complete on-line manual using the help and text windowing capabilities.

In addition, menu options that pass control over to a form can further refine the developer's choices by enforcing a correct selection from the menu. Furthermore, the form can also carry additional messages, help screens, and custom error messages.

During the process of creating a menu system, each full screen and each form becomes a separate file. While this enables the designer to take a modular approach to building the system, this process also can cause some confusion on large systems that have many menus and forms.

The SCAT program allows the designer to pack up all of the screens that relate to an application into one neat .CAT file. Once the screens are packed, they do not need to be unpacked for program execution. This capability is a valuable feature for corporate user-support departments that standardize menus and options because all of the menus can be packed into a catalog file and then distributed to the user as one file.

The pop-up window display utility, WINOUT, is useful either inside the LAN Shell or called from the command line. It creates a window of user-specified size (up to full screen size) and can display either a text file or the output of a command in the window.

The SCCHART utility provides a painless way to inspect the entire menu structure without manually invoking every choice on each menu. It prints a report of the menus being used, details the nesting of menus, and shows the help and prompt messages.

The Screen Execute program starts the menu system and is executed with parameters that call up the initial menu or catalog of menus and options, such as date and time display.

Installing LAN Shell is a simple process using the install batch file. The full installation creates a series of directories, including a LIBRARY directory for Reference Point, a network document manager (available separately at extra cost from LAN Systems) and a PROGRAMS directory that has subdirectories for LAN Shell, Lotus 1-2-3, Ashton-Tate's dBASE, and other popular software packages. Although this is a reasonable way to set up directories, they may be incompatible with the existing installation—read the installation documentation carefully to determine the best setup.

LAN Shell is a sophisticated and well-designed series of programs. The menu-design portion, however, takes time to master and the documentation is a little vague in some sections. While all the features of the software are addressed in the manual, they are not always clearly explained. The idea of a form, for example, a central design feature of LAN Shell, is not described in enough detail in the documentation.

Overall, the LAN Shell is a superior collection of tools and utilities that makes menu building and maintenance a smooth and creative process. The product, however, is designed for the network manager or administrator, not for the end user—it is much easier to use the system's menus than it is to design them. Because of the LAN Shell's many options, the developer unfamiliar with the program should allow plenty of time for experimentation. The first menu system may take longer than expected to complete, but the results will be worth the wait.

—CHERYL C. CURRID and
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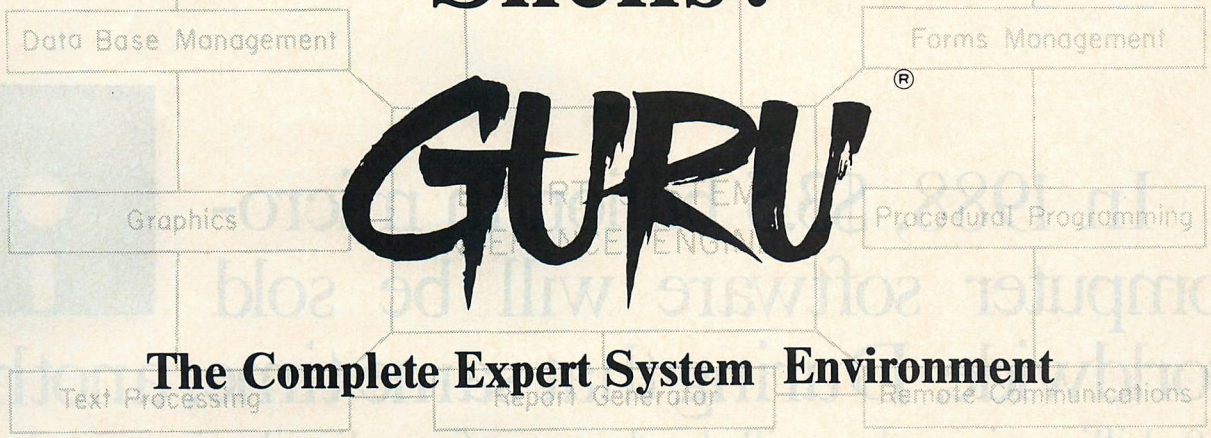
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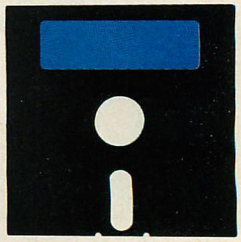
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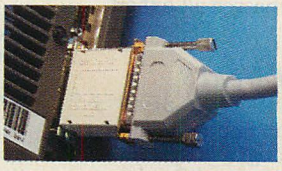
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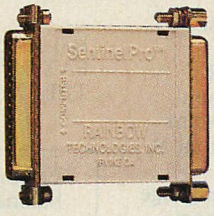


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TED MIRECKI

TECH NOTEBOOK

A forum for sharing solutions to technical problems

1 DOS 4.0 BOOT
2 TOKEN WINDOWS
3 POCKET MANUAL

After forays into the brave new world of OS/2 over the past several issues, this month we are firmly back in the world of DOS. I almost said the *familiar* world of DOS, but the first item is about a not-yet-familiar DOS version, 4.0.

PC Tech Journal is conducting a comprehensive technical evaluation of this new version of DOS, and a full report is planned for an upcoming issue. One anomaly that we found, however, deserves immediate mention so that if you run into the problem, you have the solution at hand. The problem concerns a serious but easily fixed incompatibility of DOS 4.0 with hard disks created by non-IBM versions of DOS and OS/2.

The second item gives information on running Microsoft Windows/386 on a token-ring network. Usually, problems on this type of network are related to the hardware design of IBM's Token-Ring Adapter, so they could occur with any network operating system. Our experience has been with Novell Advanced SFT NetWare 2.1. The solutions, however, should be applicable to any network software running on this hardware.

The third item this month is not a direct solution to any particular technical problem, but rather a brief evaluation of a fact-filled booklet that can solve many future problems for technical support personnel.

Before beginning the main event, I would like to call your attention to the subtitle of this department—especially the word *sharing*. Please share your solutions with your fellow readers—if you have found some ingenious way around a technical problem, let the world know about it. Send your submissions to my attention at *PC Tech Journal*, Suite 800, 10480 Little Patuxent Parkway, Columbia, Maryland 21044. You may also submit mail via MCI mail, addressed to TMirecki.

1 DOS 4.0 INCOMPATIBILITY

In the nine versions of DOS that have been introduced over the past seven years, the one constant has been the downward compatibility with regard to disk formats. All versions of DOS could read a disk created with any previous version. The converse was not necessarily true—the price paid for disk format advances, such as double-sided diskettes (introduced in DOS 1.1) and smaller clusters (DOS 3.0), was that the new disk formats were not recognized by older versions of the operating system. But there was never any fear that a disk would become unreadable to a new DOS version.

Surprisingly, this changed with DOS 4.0. Upon booting my system (from a diskette) with the new version, I was dismayed to discover that it would not recognize my hard disk. All I/O attempts produced the message "Invalid media type error" and gave the standard Hobson's choice of "Abort, Retry, Fail?"

Perhaps the problem was that the hard disk had been partitioned and formatted with OS/2. Although DOS and OS/2 use the same disk format, and although DOS 3.3 has no problems reading this disk, it is possible that version 4.0 is more particular. I backed up the disk and reformatted it with DOS 3.3. DOS 4.0 then recognized the hard disk with no difficulty. When I reinstalled OS/2 on the boot partition, however, the problem returned, but only for that partition. Formatting the disk with DOS 4.0 produced the same result—the boot partition became unreadable to the new version of DOS after OS/2 was installed.

This is serious. If IBM and Microsoft have bent over backwards to make sure that OS/2 is compatible with DOS disks, why would there now be a version of DOS that is incompatible with OS/2 disks? Further tests on a number of systems indicate that OS/2 as a whole is not the culprit. DOS 4.0 recognizes disks with IBM's OS/2 1.0 on them, but it does not recognize Microsoft's OS/2 version 1.1.

After a few more tests and some poking around with a debugger, the answer became clear. To DOS 4.0, it does not matter *which* operating system owns the disk, but *whose*. The ownership of a disk partition is established in its boot record, sector 1 on track 0. Table 1 shows the format of the boot record used in all versions of DOS since 2.0 (and now OS/2.) The layouts of the BIOS Parameter Block (BPB) and the additional data vary with each version of DOS.

The eight bytes beginning at offset 3 identify the brand and version of the operating system that created and wrote the boot record. Operations that write the boot record include formatting, the SYS command, and the procedure that installs OS/2 on a disk without disturbing the existing format. Until now, the contents of this field were strictly informational and not examined by the operating system. DOS 4.0, however, requires that this field begin with the three characters "IBM" followed by one or two spaces. Adding any other spaces or characters produces the "Invalid media type error" message.

As one would expect, all versions of DOS and OS/2 that are sold by IBM insert the acceptable boot identifier. Surprisingly, Compaq's OS/2 and DOS versions since 3.3 also place the "IBM" identifier into the boot record. (Did Compaq know something?) Versions of DOS and OS/2 from other sources, however, use either "MSDOS" or "OS2" in the boot record.

Fortunately, DOS 4.0 is the only operating system at present that is so particular. Therefore, a disk with an unacceptable identifier can be easily

TABLE 1: *Boot Record Format*

DECIMAL OFFSET	LENGTH	DESCRIPTION
0	3	Jump to boot code
3	8	OEM name and system version
11	*x*	BIOS Parameter Block (BPB)
11+*x*	*y*	Additional disk format data

All versions of DOS since 2.0 (and now OS/2) use essentially the same layout of the boot record. IBM's DOS 4.0 is the first version to check the contents of the original equipment manufacturer (OEM) identifier field for the characters "IBM."

patched to satisfy DOS 4.0, with no adverse effect on any other operating system that needs to read that disk.

To do the patch, you need to use a low-level debugger (such as DOS DEBUG or Microsoft SYMDEB) or a disk-patching program (such as the Norton Utilities). The following sequence of instructions is for DOS DEBUG. Make sure to back up the disk before doing this.

```
DEBUG
L CS:100 2 0 1
E CS:103 'IBM '
W CS:100 2 0 1
Q
```

These instructions assume that you are patching the C: drive; if not, change the drive number in the L and W commands (0 = A, 1 = B, an so on). Also note that in the E command, there must be a space after "IBM" and before the closing quote.

Reboot the system; if this fails, reboot from a diskette and transfer the system (using SYS) to the drive with the *same* version of the operating system that was on it originally. If this does not work, reformat it and restore from your backup. If the disk boots with the patch installed, reboot the system with DOS 4.0 from a diskette. The disk should now be readable.

Hopefully, branding hard disks with the name of the operating system vendor will not become a trend. If it does, one of the major attractions of DOS—the interchangeability of data over millions of systems worldwide—will go by the wayside.

2 WINDOWS/386 ON TOKEN-RING

For much of the 1980s, every year had been proclaimed the "year of the LAN." This kind of talk has died down now, indicating that perhaps PC users are talking about local area networks less and using them more. One of the main reasons for the slow acceptance of networks was that many applications and operating environments were incompatible with LANs.

At *PC Tech Journal*, for example, users were divided into two camps: those who refused to use the network because it would not run Microsoft Windows, and those who eschewed Windows because it would not run on the network. Fortunately, making such a choice is less necessary today, as almost all software makes an attempt to operate in a LAN environment.

But problems with the network still remain. A case in point is Microsoft Windows/386 running on a network implemented with the IBM Token-Ring Adapter (TRA). Although Microsoft claims that Windows/386 version 2.1 is fully compatible with several network operating systems running on this hardware, many users have experienced problems. On a machine logged into a network, Windows/386 either refuses to start up or else unpredictably crashes the system.

Fortunately, there is an easy solution to this problem that involves the insertion of several statements into the WIN.INI file. Although undocumented, this information is readily available from Microsoft product support. Rather than simply giving you the solution, let me describe the problem briefly so that you will know why these statements are necessary.

When Windows/386 starts up, it establishes an expanded memory environment compatible with the Lotus/Intel/Microsoft expanded memory specification (EMS) using the memory-mapping capabilities of the 80386 processor. EMS requires at least 64KB for page frames in high memory above the video buffers (see "EMS 4.0 Pulls Together," Ted Mirecki, July 1988, p. 72). To find a home for the page frames, Windows scans the memory between segment addresses C400H and E000H, looking for a 64KB area that is free of ROM and RAM. Because EMS version 4.0 can use more than four page frames, Windows/386 takes any other free 16KB blocks in addition to the primary page frames.

So far, this is no different from many other expanded memory manager (EMM) drivers that adapt themselves automatically to the system configuration. The problems come in the presence of an IBM TRA. Like many I/O cards, this adapter inserts memory, both ROM and RAM, into the high-memory area. The difference is that the TRA hides this memory from the system and maps it into the system address space only at interrupt time—that is, when it actually is communicating with the network.

At other times, the memory is invisible. You can verify this by peeking around with DEBUG in the address range where the TRA places its memory (this location varies depending on installation parameters; see the *IBM Token-Ring Adapter Technical Reference*). You will see the same pattern (typically FFH) as in any unpopulated memory region. This is exactly what the Windows start-up procedure sees, so it maps expanded memory pages into that area. Subsequently, when the TRA lays claim to the same area, it trashes whatever Windows put there via EMS page mapping. At this point, consider yourself lucky if you can reboot the system from the keyboard; usually, you must reach for the big red switch.

The answer to this problem is to tell Windows which addresses are off-limits. This can be done with the following statement in the WIN386 section of the WIN.INI file:

```
emmexclude xxxx yyyy
```

where *xxxx* and *yyyy* are the starting and ending segment addresses (in hexadecimal, without a trailing H) used by the TRA. This ensures that the area is not used for EMS page frames.

This usually solves the problem, especially on machines with the AT bus. A different approach may be required on PS/2 models. Here, high memory is crowded because the top 128KB, beginning at segment E000H, is reserved for system-board ROM. Other adapters, such as the TRA and the ESDI disk controller, use various parts of the segment beginning at D000H. Although the configuration program can set these adapters to use one of a wide variety of addresses, not all software

can recognize all possible addresses. For example, the Micro Channel TRA can be configured with ROM on any 8KB boundary, and RAM on any 16KB boundary, between segments D000H and DE000H. Novell NetWare, however, recognizes only six of the many possible address combinations. As a result, there may not be a contiguous 64KB in high memory for use as the primary EMS window.

The solution in this case is to extend the memory available to EMS below segment C400H. This lower limit was chosen in order to stay clear of the EGA ROM that resides at segment C000H. On PS/2 systems, video is implemented with VGA ROM on the system board, so that the 16KB just above the video buffer is free. To make it available for EMS page frames, put the following statement into the WIN386 section of the WIN.INI file:

emminclude C000

This statement does not automatically put page frames at this address, but merely extends the area that is scanned to determine if it is, in fact, free. The included area of memory is not used for page frames if Windows finds either ROM or RAM there.

Another WIN.INI statement can be used to specify the absolute location of the EMS page frame:

emmpageframe xxxx

Windows puts the page frame at the indicated address without first checking to see that the area is unoccupied. You must use this statement with care, and only when you are confident that the address is at the beginning of an empty block of 64KB.

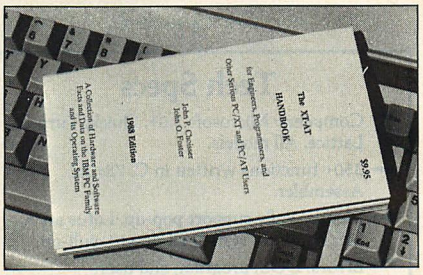
Special configurations may call for different specifications; if some combination of the above statements does not solve the problem on your system, check with Microsoft Product Support for more specific recommendations. In any case, remember that you may need to change your WIN.INI file if you make changes to your system (for example, adding a second TRA or changing the disk controller).

The problems with the TRA and with crowded high memory on PS/2 models are not unique to Windows. These problems also appear in other implementations of expanded memory on 386 systems. For example, installing 386-to-the-Max from Qualitas Inc. (see Product Watch, Steven Armbrust, December 1987, p. 197) requires almost identical parameters under similar circumstances. Unlike Windows, however, most of the other 386 packages document the parameters.

Undeniably, networks and multitasking environments are two of the most useful developments in desktop computing. Running both together provides a synergistic effect far exceeding the benefits of either one alone.

3 POCKET REFERENCE MANUAL

If you support a large number of PC users in a corporate setting, you must carry a multitude of facts around in your head. While walking down the hall, you are often stopped to solve a user's pressing problem, and you are expected to have the answer at your fingertips. Usually, you would have to tell the user to wait while you go get the reference manual. On the way,



The *XT-AT Handbook* condenses facts concerning hardware, BIOS, and DOS, but does not replace full-size manuals.

however, other users may stop you for help with their pressing problems that just cannot wait.

With the ever-increasing number of PC models and operating system versions, carrying all the facts around in your head becomes impractical. Instead, try carrying them around in your pocket. *The XT-AT Handbook* by John P. Choisser and John O. Foster is a compact compendium of facts on PC/XT and PC/AT hardware, BIOS, and DOS. It is available from Annabooks (9974 Scripps Ranch Blvd., Suite 25A, San Diego, CA 92131). The price is $9.95 for a single booklet and $5.00 each in quantities of five or more.

At 3.5-by-6 inches and 76 pages, it is compact enough (see photo) to find a permanent home in your shirt pocket. No, it will not replace the *AT Technical Reference Manual*, but the information that the booklet contains is sufficient to save you many trips back to your office for the larger volume. More importantly, it can save you from making users unhappy.

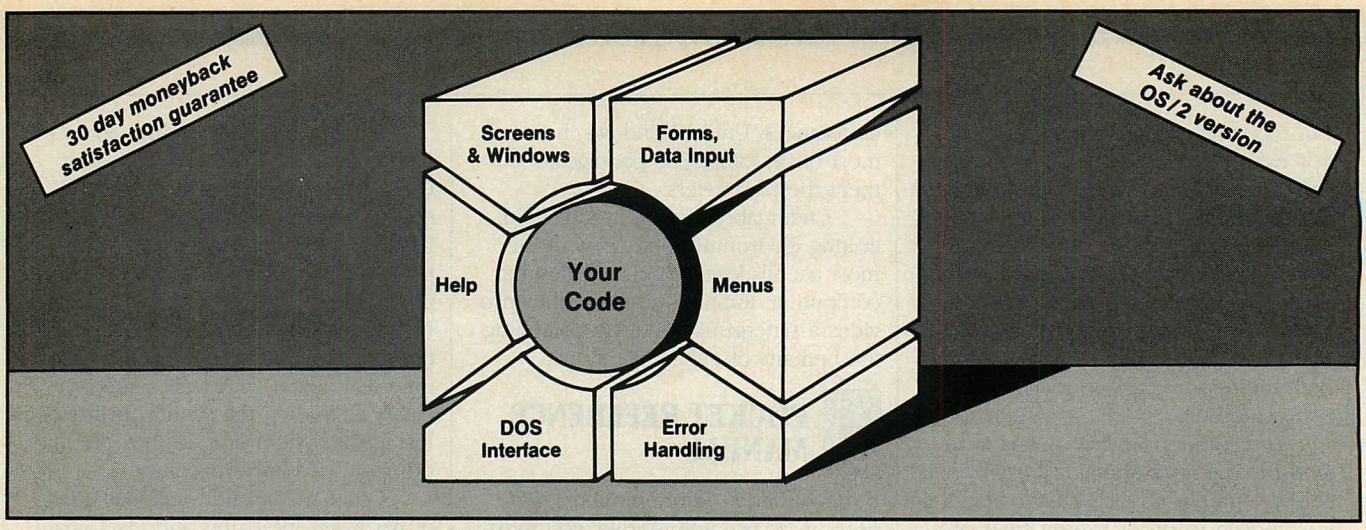
The book is divided into 38 sections, each one is 1 to 4 pages long. Over three-quarters of the book (23 sections, to be exact) deals with the hardware. The information you will probably use the most is the list of power-on error signals and, especially if you support many basic PCs and XTs, the system-board switch settings. Having this booklet with you is almost as handy as finding the settings printed inside the system unit, as they are in Compaq's Deskpro machines.

Other information includes a list of hardware interrupts and DMA channels, an I/O address map, and programming information for various controller chips including the 6845 Graphics Controller, 8237 DMA Controller, 8250 Serial Communications Controller, 8253/54 Timer, 8255 Programmable I/O Controller, and 8259 Interrupt Controller. Other less frequently needed (but nevertheless useful) data include the pin layout and signal descriptions of the expansion bus, and pin layouts for every kind of cable likely to be used with a PC, such as serial, parallel, video, keyboard, and game adapter. The differences between the XT and AT are clearly noted; information specific to the latter includes a list of 55 hard-disk types and the layout of the CMOS configuration memory.

The coverage of software topics is much lighter. The booklet contains terse reference lists of DOS, DEBUG, and EDLIN commands (you *do* remember EDLIN, don't you?), and of BIOS and DOS interrupts. In addition, tables of ASCII codes and hexadecimal arithmetic are included. The booklet is designed primarily as a hardware reference, so the lack of in-depth software coverage is acceptable. A list of functions for interrupts 10H (video), 13H (disk I/O), and 21H (DOS services), however, would have made a good product an even better one.

One fault is that, despite the cover date (1988), the information is not entirely current. DOS commands added as long ago as version 3.1 (in early 1985)—JOIN or SUBST, for example—are not listed in the DOS section. More significantly, the EGA and VGA are not covered in the video section.

Still, this is a worthwhile addition to the toolkit of anyone whose job it is to know the details of the PC's operation. It is a fitting replacement for the plastic pocket protector and colored markers that, in the days of hard-copy program listings, were the trademark of systems professionals.



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Tech Specs

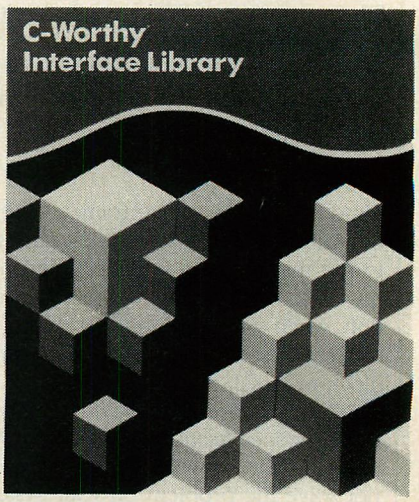
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About four years ago, the Personal Computer Professionals Association played host to a team from IBM; the IBM presentation was livened by a question from the floor concerning the sluggish performance of the PC version of IBM's DisplayWrite word processor. With a sheepish grin, the IBM representative said gamely: "Well, it runs pretty well on an AT." This broke up the entire room, because the idea that anyone would buy a developer-class system like an AT for word processing was considered a joke.

Today, though, reviews of new word-processing packages routinely contain such warnings—comments that a 32-bit chip and several megabytes of RAM will be needed to provide reasonable speed in the text-editing phase of document production. *Text editing!* Yes, I know these applications can do a lot more than this, but is that any excuse for such sluggish performance of the most basic functions?

It's just another example of the spreading tendency to use desktop computing resources—processor, memory, display capabilities—as quickly as they become available. Several high-priced packages clearly have gone *beyond* all practical limits.

It is as if the need for a more powerful system somehow confers more status on the user and his or her task. This is reminiscent of the ancient Mesopotamian temple towers, the so-called *ziggurats*, that are the historical basis for the legend of the tower of Babel: the taller the tower, the closer it was supposed to bring you to the source of all truth and power. Buyers of floor-standing PCs take note: are you solving bigger problems faster, or have you entered the ziggurat zone?

THE WORST SORT OF SORT

I got a call recently from the editor of an academic journal. One of her staff had just compiled an extensive bibliography, about 40 pages at 20 entries per page, and the editor was now ready to alphabetize the entries by author name. "The word processor has a 'sort' function," she told me, "but it keeps saying 'out of memory.' What are we doing wrong?" They were using Microsoft Word 4.0 on a well-equipped IBM PS/2 Model 50—not the fastest machine in the world, perhaps, but well above the median. Was it completely unreasonable to attempt this task without using a full-blown database product?

To test the idea, I wrote a quick program to generate 800 random names—unreadable, perhaps, but about the number and length of the strings that were being used as sort keys for the bibliography. To each of the names, I appended the same 255-character entry (the entries did not need to be unique to make the test realistic). The resulting list could be sorted on a comparable machine by an in-memory flat-file manager (with disk swapping, but not true database capabilities) in well under a minute.

So why did Microsoft bother to put that function into the product at all if it doesn't have enough starch to handle nontrivial tasks? Of what use is a sort function that cannot handle more than a few dozen entries? Word can use the disk, as well as the memory, during editing; would it have been so unreasonable to use these facilities to provide more robust sorting as well?

Indeed, I have relied on the sorting function of the Macintosh version of Word. But a function should handle the professional user's reasonable requirements on representative hardware, or else it is really no feature at all—just meaningless size and complexity with no real benefit. I fear that Word has entered the ziggurat zone.

BIG MEMORY? FORGET OS/2 . . .

OS/2 also comes to mind. I suppose we should be grateful for what we've gotten (I say between clenched teeth), but it really comes too late. In an attempt to keep OS/2 compatible with existing applications, IBM waited too long to give it to us. Most of the people who wanted a system like OS/2 on the day they bought their first ATs have moved to 80386 machines by now.

While IBM is throwing its full weight behind OS/2, it is not using this operating system itself in all cases. Interleaf Inc.'s port of its desktop publishing system may be the best example to date: it was ported to the PS/2

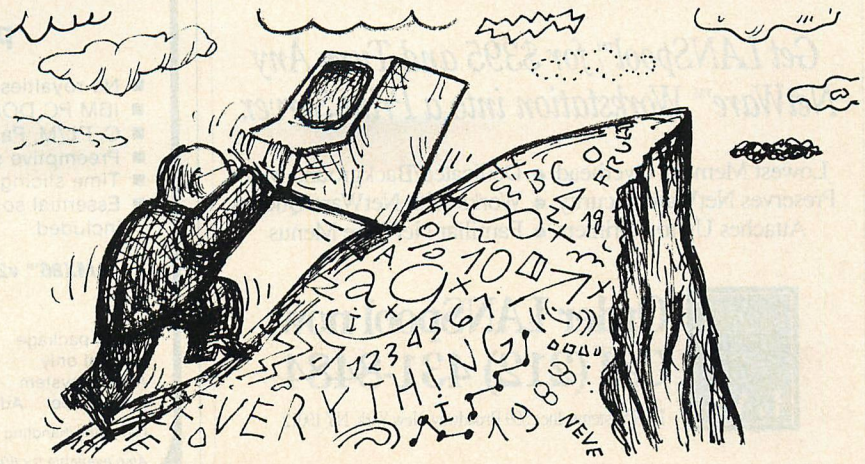


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Model 80, for sale under the IBM label, under *DOS* rather than OS/2.

The reason, apart from the fact that OS/2 barely was hatched at the time the port was in progress, was said to be the developers' preference for working with the large, flat address space of 386 protected-mode memory. This is done by means of the Phar Lap DOS extensions used by Interleaf and many others with similar requirements.

When you combine a superior native mode with hardware support for virtual 8086 sessions, the 386 programming model makes an 80286-based OS/2 look like something that was done just to prove it can be done—ignoring the fact that the result is not very useful. For the moment, OS/2 is a world-class ziggurat.

THE MORE THINGS CHANGE

Am I just replaying the same sad tune that CP/M advocates were singing when DOS began to make its way into the world? "Who needs change? The installed base is what matters," and so on. I don't think so, and I can cite a solid example to support my argument that today's situation is quite different.

I was working with a firm that develops substantial, heavily formatted documents as a major component of its total mix of goods and services. It has adopted Ventura Publisher as its PC-based desktop publishing system and wondered if a package in this class didn't call for heavier iron than the AT compatibles currently favored as its standard office machine.

When the people at this company tried "live-ammo" tests of users doing representative tasks on 386 and 286 hardware, they discovered—to their considerable surprise—that the difference between actual, wall-clock task times on the two machines was negligible. The undeniably higher speed of the 386 in machine operations had crossed the threshold to the point where the machine merely was waiting longer for the user's next action. In their own words, the 286 machine "kept up with the user—what more did we need?"

Even the most rabid supporter of CP/M on Z80-class hardware would have to admit that the platform, not the user, was the bottleneck for overall speed. With human evolution being the slow process that it is, I suspect that faster users are a long way off; affordable machines that can keep up with the user are therefore a critical milestone.

SMALL CAN BE STRATEGIC

I was speaking with another in-house systems designer whose company recently has upgraded its primary development language product—expanding addressable memory by a factor of 10. He predicted that he is "set for the next five years at least: the limit on what we can do is my time, not the tools." Is he an early adopter of OS/2? Not at all—he is a developer who recently has upgraded to Borland's Turbo Pascal 4.0 and who is pleased he can now use the whole 640KB DOS space (albeit in 64KB segments) instead of being confined to just 64KB.

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THE OTHER END OF THE CURVE

I am making the case that the current state of the art provides as much performance as most users can fully exploit, and that the hardware resources of current platforms can support the requirements of genuinely strategic applications. Does that mean no meaningful innovation is going on out there? Certainly not. We just need to observe that better performance on an affordable platform is just one end—the high end—of the price-performance curve. We also could look at the low end of the curve, describing a rapid decline in the weight, size, and cost of an "adequate" platform. This sounds dull at first, but it turns out to be at least as exciting as the ascending ladder of megahertz and megabytes.

Think for a minute about what computers really ought to be doing for your company. Sure, your power users are getting all glassy-eyed over the prospect of being able to turn their desktop machines into multitasking workstations, but what about the real choke points in the operation: the shipping and receiving system, for example, or the field follow-up on customer satisfaction with your product? And what about meetings? What about the time spent merely transferring information among participants, rather than actually solving problems?

How many of these *real* problems are addressed effectively by multimegabyte applications that require a wall-sized monitor to accommodate all their menus (not to mention a precious square foot of clear desk space for the mouse to get its recreation)? By contrast, how many of those problems would be better attacked by inexpensive, possibly special-purpose information tools that are out where the action is instead of theorizing from the desktops of comfortable offices? Did somebody say *laptops*?

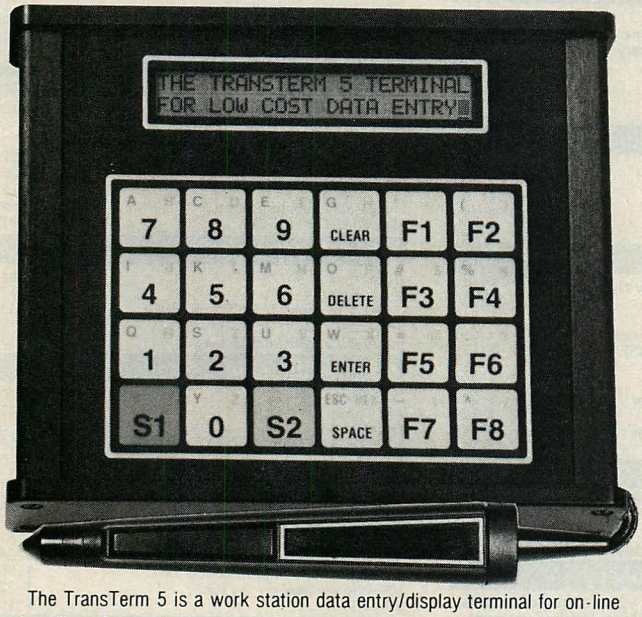
DOWNSCALE DEMAND

A year ago, my own long-range development plans were based on using an advanced workstation-class machine for artificial-intelligence software development—specifically in the area of business-decision support, to be assisted by intelligent tools for simulation and risk analysis. After working more than two years in AI technology transfer, I'm now convinced that mainstream acceptance requires adding AI benefits incrementally to everyday applications, rather than developing new AI-based systems from scratch.

From this new perspective, I see the big bit-mapped workstation—the machine everyone thinks of when they consider AI systems—as the worst kind of ziggurat. It is big, impressive, built from scratch for purposes all its own, and not connected to anything else.

So, I'm writing this column on my first laptop machine, which in less than two weeks of use has become my primary desktop machine as well. Okay, so it is a tactical nuclear laptop, specifically a GridCase 1530 (from Grid Systems Corporation)—a 12.5-MHz 386 with 2MB of RAM and a 27-millisecond, 40MB hard-disk drive (for a review, see Product Watch, David Claiborne, August 1988, p. 131). This battery-operated package is perfectly capable of serving as a no-excuses main machine, although it might need a RAM upgrade (it can handle up to 8MB) to run OS/2.

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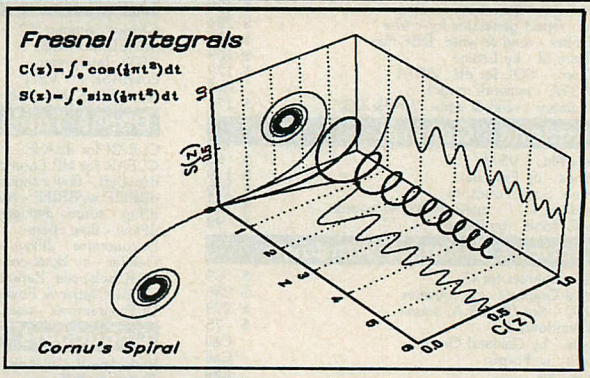
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I relish the recovery of long-lost desk space and the major reduction in office noise level. The laptop's backlit LCD screen is perfectly acceptable for writing, communications, and financial work, and it provides substantially better battery life than the beautiful-but-demanding plasma display that gets all the attention in reviews of this unit. The keyboard is compact (using an additional Shift key called Function to type, for example, square brackets and braces), but keyboard utilities let you make any keystroke vocabulary reasonably convenient. The keyboard also has a better feel than most full-sized ones shipped today: it has positive snap-through, but with minimal noise—more of a "thunk" than a "clack."

Most important, though, the GridCase has changed my perspective on where a machine should be able to go to make it a tactical weapon instead of a big, dumb, stay-at-home missile. Scenario: remember the Apple commercial where a group in a strategy meeting keeps asking, "Who can do the charts?" and so on, with the Macintosh user being the one who keeps volunteering?

I can envision a subsequent meeting where the laser-printed charts are projected on the screen and the boss says, "What are the pieces that make up that number?"—pointing to one of the shaded bars. The person presenting the charts stammers something about updating the analysis, while another person quietly boots up a laptop and plugs an LCD presentation panel into the external monitor port. "If I may?" she asks, and displaces the chart with the LCD. The whole character of the meeting changes, because the analysis is now dynamic instead of being fused to a piece of plastic.

This isn't fantasy: I've seen it in action, and it's terrific. A laptop and an LCD take up less space than a first-generation portable PC alone. This is *the* package for state-of-the art business presentations.

PARTS IS PARTS

For another example, one of my students recently told the story of a system that he and his co-workers created to monitor the voluminous inventory of precision parts in an industrial firm. I went into the presentation expecting to be scared stiff by yet another user-developed system, stuck together with minimal understanding of the tool and with none of the discipline needed to make it function under anything but ideal conditions.

I was flabbergasted. They had done it *all*—macro menus for every normal pathway through the system, internal cross-footing, and other even more advanced consistency-checking features. The system's information was so timely and detailed that it quickly became an important part of the stock-keeping and reordering process, which previously had used only indirect and approximate indicators.

So, what went wrong? Management, in its typically inscrutable fashion, decided to integrate the system with corporate costing functions and decreed that it should be rehosted on the corporate minicomputer. Never mind that key information would be lost from the user screens because of differences in layout; never mind that printouts now would have to be sent via corporate mail rather than generated on the spot; never mind that monthly reporting cycles now might make them wait for days just to get *time* on the machine, with the worst

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delays inevitably occurring just when a major order hinges on the ability to commit to the shipment of sufficient quantities of specific parts.

The result, for the moment, is a disaster, and I have one sneaking suspicion: if the system had been implemented on genuinely portable machines—which was the next step planned before the system was uprooted from the PC architecture entirely—it might have created a strong psychological barrier against isolating the tool in the proverbial glass house. There might have been a little more incentive to overcome the minor obstacles to letting the PC-based system communicate with the minicomputer (rather than merging the systems into one) if the PC side had been more conspicuously mobile—seen to be right out there on the floor, instead of living in a desk-bound box that looks (to the uninformed eye) suspiciously like that minicomputer up the street.

MAXIMIZING THE OPTIONS

Am I talking out of both sides of my mouth, praising the glories of small systems while writing this very column on a 386 (even if it runs at only 12.5 MHz)? If waiting faster were all that the 386 could do, I would be guilty as charged, but my decision really was made not by the extra speed but by a memory-management utility from Qualitas called 386-to-the-Max.

This program makes the 386 the inescapable choice of even the everyday DOS user (see Product Watch, Steven Armbrust, December 1987, p. 197). It lets you use memory between the top of your 640KB and the bottom of video RAM for normal DOS operations; it lets you put resident utilities and now, with the accompanying 386LOAD utility, even put device drivers in the space between the top of video and the 1MB line; and it lets you turn the rest of your RAM into any mix you like of extended and EMS 4.0-compatible expanded memory.

The proof is in the RAMming: with drivers loaded for mouse, RAM drive, disk cache, and sundry other utilities, a desktop machine with an EGA still has 586KB of free DOS memory. A CGA machine like the GridCase also can use the 96KB of RAM between 640KB and the video buffer for DOS, so it boots with almost 680KB free.

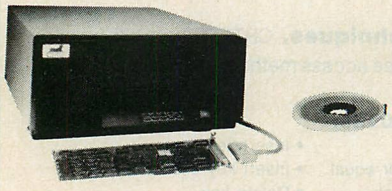
Who cares about speed; we are talking about elbow room. We are talking about being able to run child sessions that can handle almost any normal activities from the DOS top level. As Terry Myers of Quarterdeck observed at *PC Tech Journal*'s Systems Forum in June, the 386 is truly "the ultimate DOS machine." The 386 has extended enormously the useful technical lifetime of my own existing applications, and the more economically deliverable 386SX (is "SX" the opposite of "excess"?) should establish this architecture firmly as the mainstream business platform for as long as single-processor models remain the norm.

The 386 architecture is a tool, not a ziggurat—a real-life demonstration that hardware, not software, is what gets cheaper. It passes the test of providing future potential with immediate benefits, which seems to me to be the least that we have a right to expect. If we apply this test consistently to other market offerings, we may come to enjoy a variety of genuinely useful options and reject those ziggurats vying for our attention.

Peter C. Coffee is managing partner of SolveWare, a developer and business computing consultant, and is active in AI and distributed computing applications for aerospace and educational clients.

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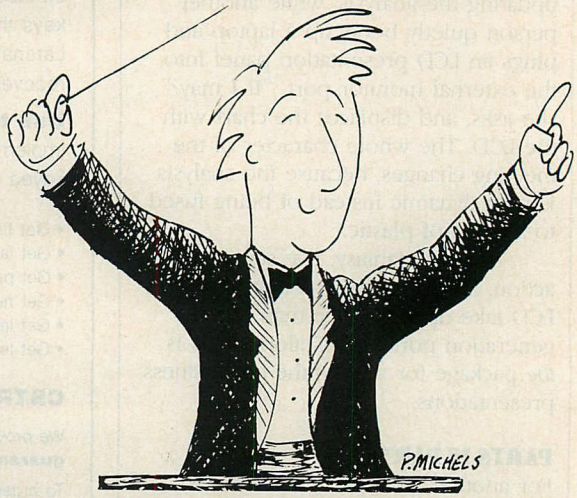
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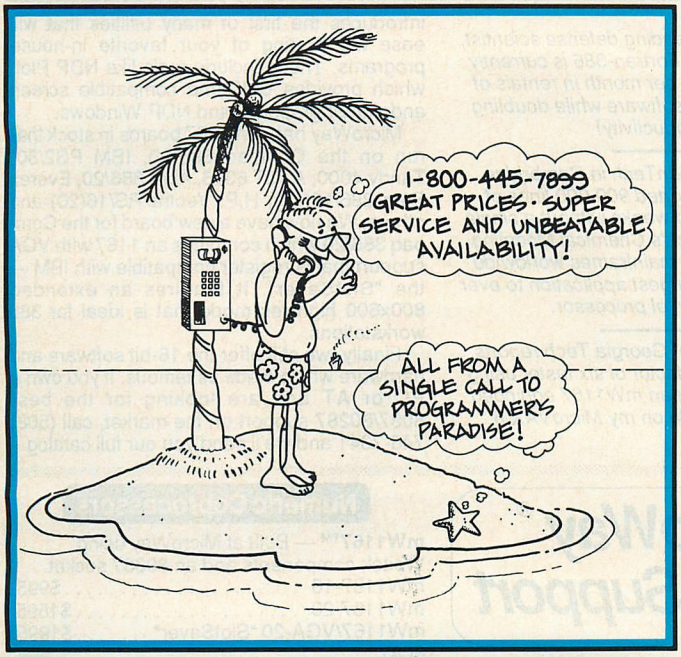
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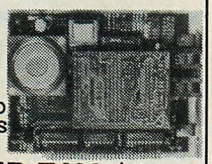
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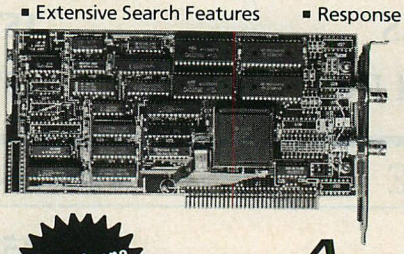
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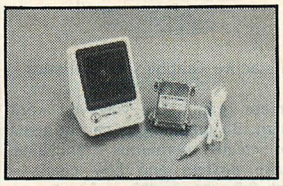
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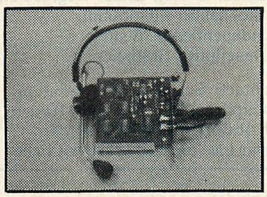
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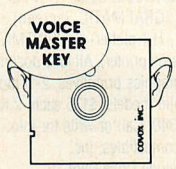
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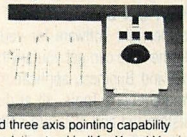
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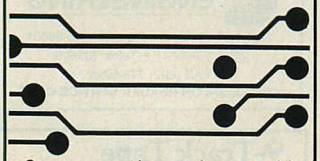
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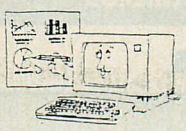
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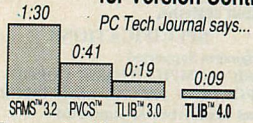
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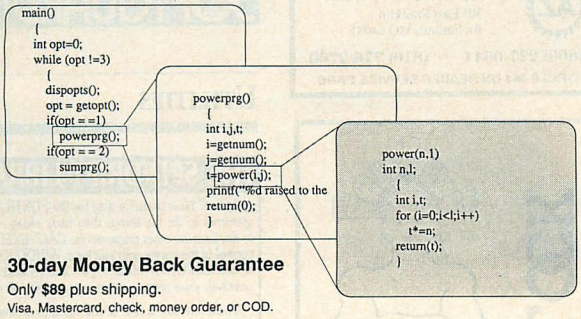
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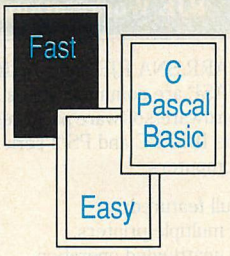
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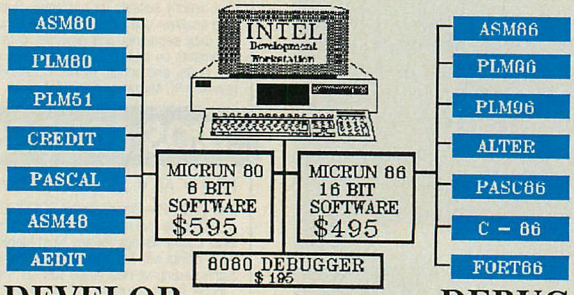
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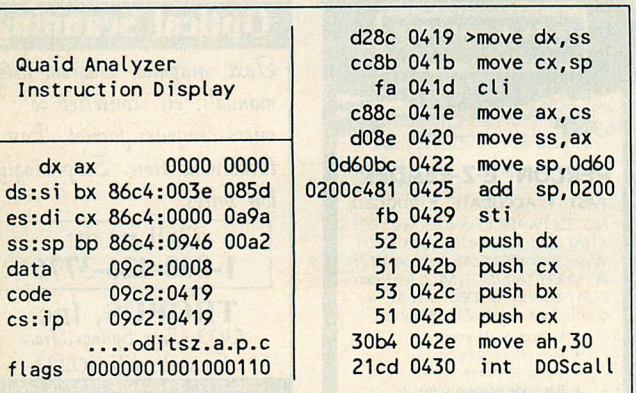
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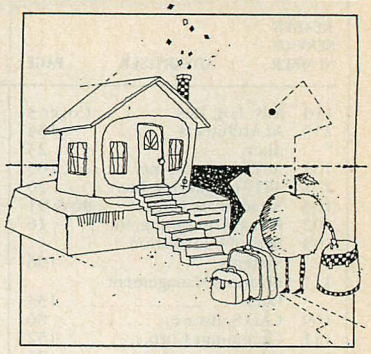
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JORDENE ZEIMETZ

PROFESSIONAL VIEWPOINT



Many readers feel PC-Mac integration is like mixing apples and oranges, but most say they are dishing up fruit salad.

Our recent *PC Tech Journal* survey asks about integration of Macs into PC environments. The responses show a close split between respondents in favor of Macs and those opposed to PC-Mac integration.

Those opposing Macs are impassioned in their opinions. Their answers are generally short—but definitely not sweet. "Are you serious? No—None—Never!" writes John L. Johnson, chief executive officer of Jontel Systems in Yucca Valley, California.

"Not now. Never. Unless a customer insists and then only if I cannot talk him out of it," says Merle D. Brown, owner of Creative Solutions in Sedgwick, Kansas.

"Macs are not cost effective (overpriced to the max!) and the development environment is too complicated," says G. David Thayer, owner of Rapidsoft in Las Cruces, New Mexico.

In general, these vociferous folks would rather eat an apple with a worm in it than use an Apple with a mouse on it. They are basically satisfied with their current arrangement of IBM PC and compatible systems, without adding any Macs into the mix.

A slightly greater number of respondents, however, say that Macs *do* have a place in their companies. Most require that the Macs connect with their PCs and mainframes. Our cover suite in July 1988 on Mac Connections was directed at these readers.

Macs primarily are embedded in areas requiring graphics, such as marketing, advertising, and engineering departments. Senior PC business analyst Mike Mariner of Storage Technology Corporation in Louisville, Colorado, sums up the state of many companies when he describes his company's Mac usage: "Marketing, technical publications, creative servicing, engineering, general business, and executives." All the applications will require PC-Mac connections "sooner or later," he says.

While the main reasons for using Macs are the graphics and desktop publishing capabilities, many find it necessary to use Macs to stay in touch with other departments and companies.

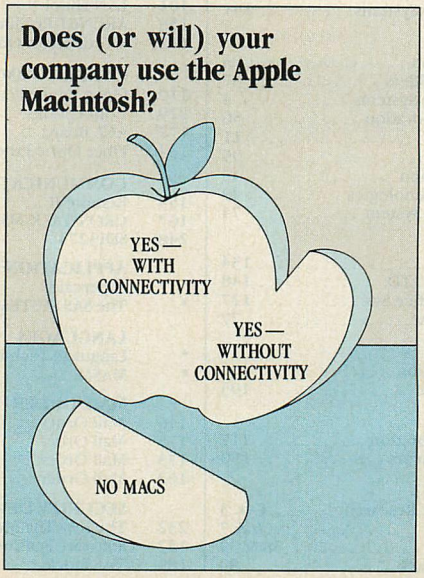
"While we do most of our work on MS-DOS machines, more and more of our customers are using Macs and we have to be able to deal with them," says Julius A. Luck, consultant with Raccoon Cove Computing, Lamoine, Maine.

Similarly, Marc Zwillinger, programmer at Sonoma State University, Rohnert Park, California, reports, "Our department has an IBM PC-based Novell network. We provide services to other departments that have Macs."

Others are developing applications on both the PC and the Mac. "I have recently written a Macintosh version of our commercial software package, 'The CPA Review,'" says Kimberly J. Christensen, director of software development for MicroMash in Englewood, Colorado.

HARVESTING APPLES

How are people making the PC-Mac connection? Boyd Paulson, professor of civil engineering at Stanford University in California, says, "We use a 3Com Ethernet [and] AppleTalk system in our department (more than 100 Macs and PCs) and [a] gateway."



Most companies require at least dual access to printers and databases and the ability to convert Mac and IBM applications back and forth. David Rawheiser, senior systems analyst with Delaware Trust in Wilmington, says, "[We] need to transfer WordPerfect files to [the Mac] for newsletters. We use [Dataviz Inc.'s] Maclink Plus 2.0."

Tony Gaddis, computer systems coordinator for Regional High Technology Training Center in Waynesville, North Carolina, says, "Sometimes we send files from one of our PCs to the Mac, using our TOPS network—usually for laser printing."

Respondents report that they connect Macs to mainframes quite often, too. Jeffrey M. Grant, planning systems analyst, Alaska Airlines in Seattle, Washington, says his company moves from "[Microsoft's] Excel to [Lotus's] 1-2-3 on occasion. All users use IBM/Amdahl-mainframe-to-Excel links to download data from [Information Builders Inc.'s] Focus for manipulation in Excel."

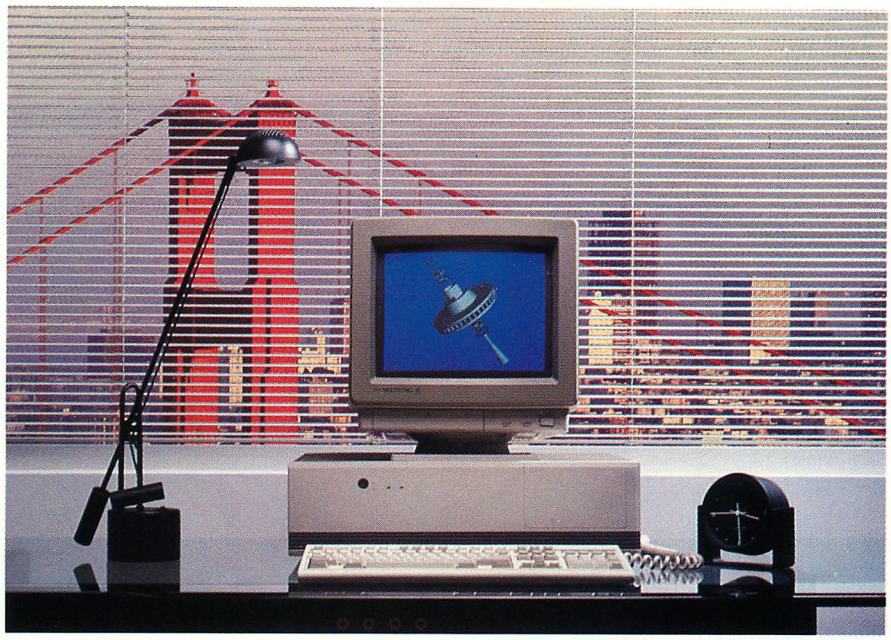
NO GARDEN OF EDEN

Whether we like to admit it or not, several realities about Macs and PCs are hitting us in the face.

First, let's set the record straight. Because PCs are already entrenched in business, people are not going to throw them out—we know that and you know that. After all, many existing PCs do their jobs just fine and the vendor support (people and parts) is already in place.

Although readers are not ready to throw out their IBM PCs and compatibles, they are buying and using Macs. This side-by-side positioning of Macs and PCs in many companies means that PC-Mac integration is on its way to becoming an accepted practice.

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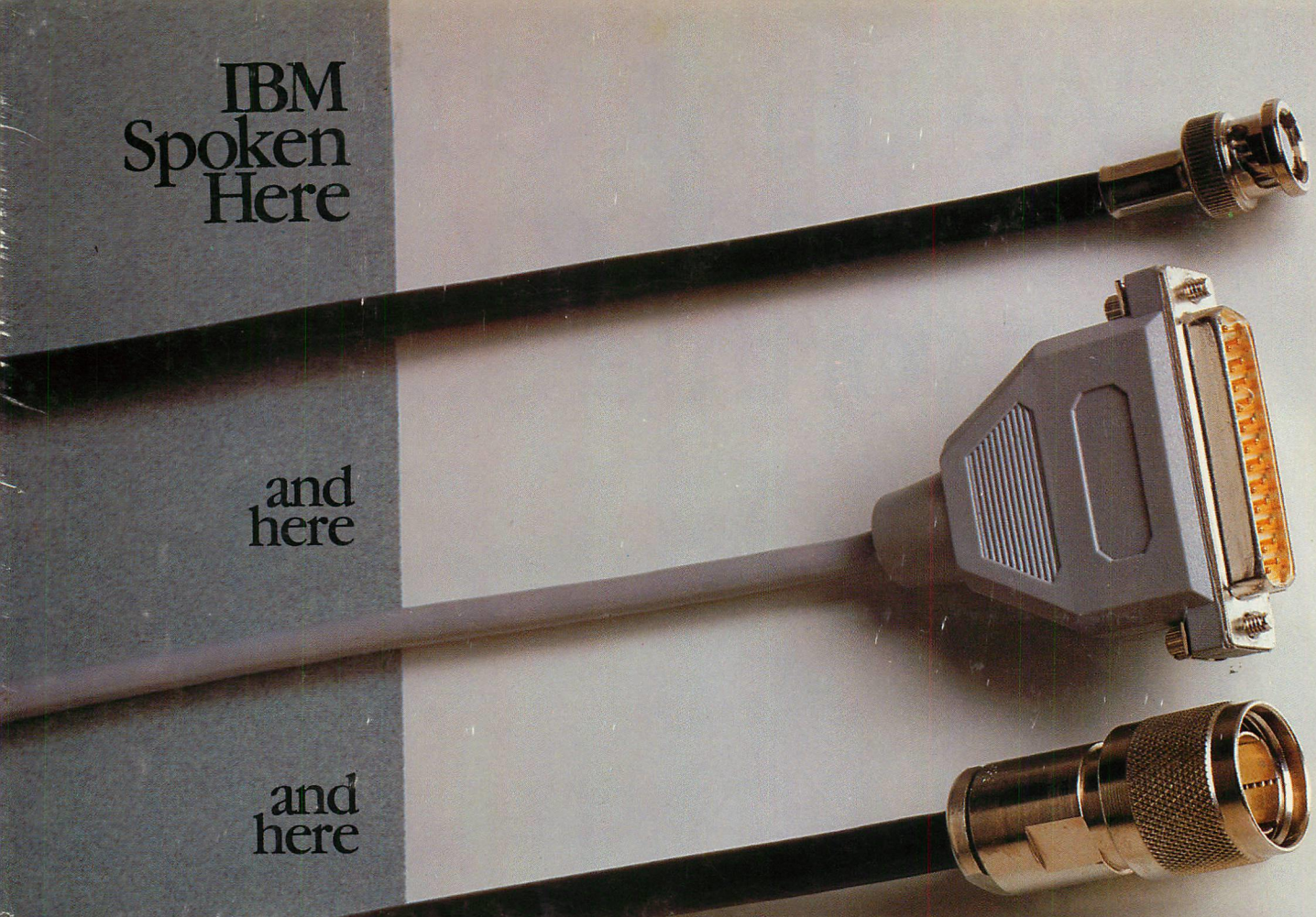
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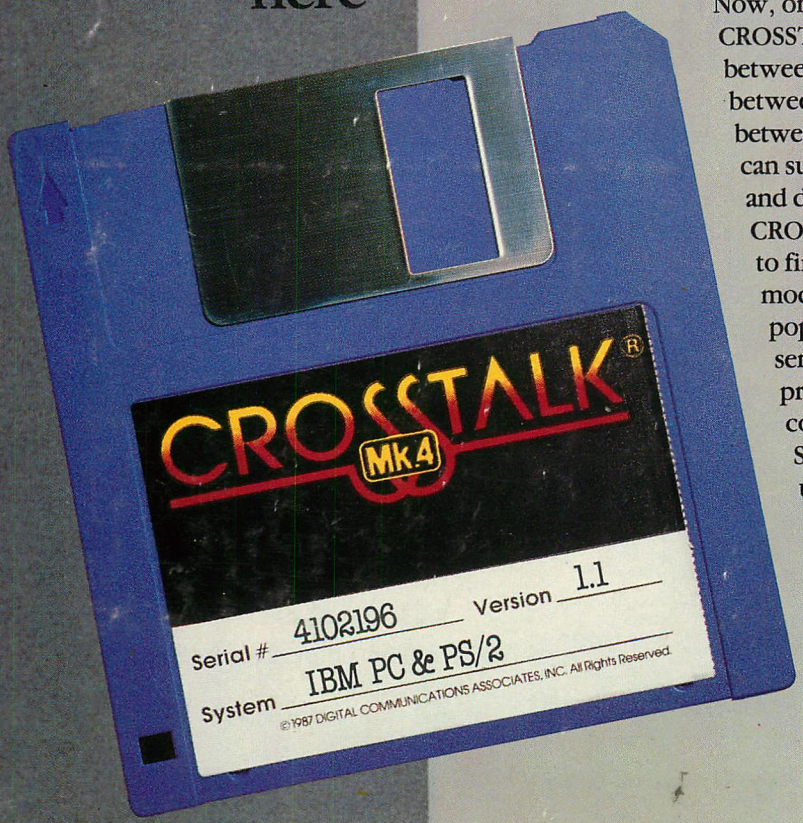
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